

***Telesonix jamesii* (Torr.) Raf. (James' telesonix):
A Technical Conservation Assessment**



**Prepared for the USDA Forest Service,
Rocky Mountain Region,
Species Conservation Project**

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Brenda Beatty, William Jennings, and Rebecca Rawlinson
CDM, 1331 17th Street, Suite 1100, Denver, Colorado 80202

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AUTHORS' BIOGRAPHIES

Brenda L. Beatty is a senior ecologist and environmental scientist with CDM Federal Programs Corporation. Ms. Beatty has over 22 years of professional experience in the environmental industry and has provided technical support for wetlands delineations, ecological surveys, threatened and endangered species surveys, ecological sampling, and ecological risk assessments throughout the country. Her experience in ecology has been used to develop species assessments, characterize biotic communities, identify sensitive ecosystems, estimate wildlife use areas, identify potential habitat for threatened and endangered species, and locate threatened and endangered species. Ms. Beatty received her B.A. in Environmental Science from California State College of Pennsylvania in 1974 and her M.S. in Botany/Plant Ecology from Ohio University in 1976.

William F. Jennings is a botanical consultant specializing in studies of rare, threatened, or endangered plant species in Colorado. Mr. Jennings regularly conducts surveys for threatened species throughout the state and is responsible for discovering several new populations of many species. His botanical emphasis is in the floristics and taxonomy of native orchids. He is the author and photographer of the book *Rare Plants of Colorado* (1997) published by the Colorado Native Plant Society and a co-author of the *Colorado Rare Plant Field Guide* (1997). Mr. Jennings received his B.S. and M.S. in Geology from the University of Colorado, Boulder.

Rebecca C. Rawlinson is an ecologist with CDM Federal Programs Corporation. Ms. Rawlinson's work has focused on the control of non-native plant invasions, conservation of native plant species, and restoration of native plant communities. She has participated in demographic monitoring of rare native plants, vegetation mapping and surveys, and restoration projects in a variety of ecosystems along the Front Range, Colorado. Ms. Rawlinson received her B.S. in Natural Resources from Cornell University in 1997 and her M.A. in Biology from the University of Colorado, Boulder in 2002.

COVER PHOTO CREDIT

Telesonix jamesii (James' telesonix). Photograph by H.D. Roberts, used with permission of the University of Colorado Museum Herbarium.

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF *TELESONIX JAMESII*

Status

Telesonix jamesii (James' telesonix) is a regional endemic saxifrage species occurring from 2,073 to 4,145 meters (m) (6,800 to 13,600 feet [ft]) in boulderfields, on cliff faces, and on rocky outcrops in tundra and mixed conifer forest communities in the eastern mountains of north-central and central Colorado. Although *T. jamesii* has been reported from Wyoming and New Mexico, no occurrences have been verified there and the state Natural Heritage Programs (NHPs) do not track this species (Fertig and Heidel 2002, New Mexico Natural Heritage Program 2003). *Telesonix jamesii* is the focus of an assessment because it is a rare species with viability concerns due to its regional endemism, small number of documented occurrences, and possible human-related and environmental threats. Currently, 12 of the 19 known (i.e., verified) occurrences of this species in Colorado may occur entirely or partly on USDA Forest Service (USFS) lands, specifically the Pike-San Isabel National Forest. Additional occurrences are entirely or partly on National Park Service lands (Rocky Mountain National Park), State of Colorado lands (Staunton State Park, Colorado Division of Wildlife State Wildlife Area), Colorado Bureau of Land Management lands, U.S. Department of Defense lands, private lands, or on lands of unknown ownership. This species is not listed on the USFS Rocky Mountain Region sensitive species list (USDA Forest Service 2003) or the U.S. Fish and Wildlife Service threatened or endangered species list. The Global Heritage Status Rank for this species is G2G3 (between globally imperiled and globally vulnerable), and the Colorado NHP ranks this species as S2 (imperiled in the state) (D. Anderson personal communication 2004, Colorado Natural Heritage Program 2004).

Primary Threats

Direct or indirect negative impacts to *Telesonix jamesii* populations or habitat by human-related activities could occur from motorized and non-motorized recreation, trail or road construction and maintenance, changes to natural disturbance regimes, invasive species introduction, structure construction and maintenance, and horticultural collection (Colorado Natural Heritage Program 2004). Those populations closest to roads, trails, or other human-related structures (e.g., radio towers, reservoirs) are likely at the most risk. Environmental or biological threats to populations or habitats of *T. jamesii* could include succession, non-native species introductions, excessive herbivory, inadequate pollination, genetic isolation, global climate change, and genetic interaction with cultivated varieties of this species. Disturbances and land management activities may maintain suitable habitat for this species or negatively impact existing populations, depending on the intensity, frequency, and type of disturbance.

Primary Conservation Elements, Management Implications and Considerations

Available records of *Telesonix jamesii* occurrences are vague in many cases, and so details about the abundance and full spatial distribution of this species are not known. At least nine out of 19 verified occurrences are estimated to have over several hundred individuals. The lack of information regarding the habitat needs, colonizing ability, adaptability to changing environmental conditions, sexual and vegetative reproductive potential, and genetic variability of this species makes it difficult to predict its vulnerability.

Features of *Telesonix jamesii* biology that may be important to consider when addressing conservation of this species (i.e., key conservation elements) include its preference for granitic substrates and rock crevices, elevational range of habitats, cliff face habitat and possibly underestimated population sizes, relatively large populations in small geographic areas, possible susceptibility to human-related activities, discontinuous distribution, showy flowers and attractiveness to horticultural collectors, and apparent ease in *ex situ* propagation and implications for natural reproduction. Priority conservation tools and future research studies for this species may include revisiting and mapping the extent of reported populations, identifying high-quality populations, reducing any imminent human-related threats to existing high-risk populations, documenting and monitoring the effects of current land-use practices and management activities, assessing the possible impact of human recreational and collection activities, assessing population trends, and studying the relationship between *T. jamesii* and *T. heucheriformis*. Additional key conservation

tools and research studies may include surveying high probability habitat for new populations, preventing non-native plant invasions, studying demographic parameters and reproductive ecology, investigating factors affecting spatial distribution (e.g., microhabitat characteristics), and assessing the effects of future management activities or changes in management direction.

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project for the USDA Forest Service (USFS) Rocky Mountain Region (Region 2). *Telesonix jamesii* (James' telesonix) is the focus of an assessment because it is a rare species with viability concerns due to its regional endemism, small number of documented occurrences, and possible human-related and environmental threats. Rare species may require special management, so knowledge of their biology and ecology is critical.

This assessment addresses the biology of *Telesonix jamesii* throughout its range in USFS Region 2. This introduction defines the goal of the assessment, outlines its scope, and describes the process used in its production.

Goal

Species conservation assessments produced as part of the Species Conservation Project are designed to provide forest managers, research biologists, and the public with a thorough discussion of the biology, ecology, conservation status, and management of certain species based on available scientific knowledge. The assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The assessment does not seek to develop specific management recommendations but provides the ecological background upon which management must be based. However, it does focus the consequences of changes in the environment that result from management (i.e., management implications). Additionally, the assessment cites management recommendations proposed elsewhere, and, when management recommendations have been implemented, the assessment examines the success of the implementation.

Scope and Information Sources

This assessment examines the biology, ecology, conservation status, and management of *Telesonix jamesii* with specific reference to its geographic and ecological characteristics in the USFS Rocky Mountain Region. Where supporting literature used to produce this species assessment originated from investigations outside the region (e.g., studies of related species), this document placed that literature in the ecological and social context of the central Rockies. Similarly, this assessment is concerned with the reproductive behavior,

population dynamics, and other characteristics of *T. jamesii* in the context of the current environment rather than under historical conditions. The evolutionary environment of the species is considered in conducting the synthesis but placed in a current context.

In producing the assessment, we performed an extensive literature to obtain material focusing on *Telesonix jamesii*, as well as information on related species and relevant to the geographical and environmental contexts of this species. We reviewed refereed literature (e.g., published journal articles), non-refereed publications (e.g., unpublished status reports), theses and dissertations, data accumulated by resources management agencies (e.g., Natural Heritage Program element occurrence records), and regulatory guidelines (e.g., USFS Forest Service Manual). We did not visit every herbarium with specimens of this species, but we did include specimen label information provided by herbarium staff from electronic databases (e.g., Colorado State University Herbarium, Kathryn Kalmbach Herbarium, Rocky Mountain Herbarium, University of Colorado Herbarium, University of New Mexico Herbarium, Washburn University Herbarium) and/or available in Natural Heritage Program (NHP) element occurrence records. Additionally, we incorporated information from studies of closely-related *Telesonix* species (e.g., *Telesonix heucheriformis*) and other Saxifragaceae species of similar habitats, where available. We avoided extrapolating from studies of Saxifragaceae species from drastically different environmental contexts. While this assessment emphasizes refereed literature because this is the accepted standard in science, we used non-refereed publications and reports as they provided information unavailable elsewhere. These unpublished, non-refereed reports were regarded with greater skepticism, and all information was treated with appropriate uncertainty.

Treatment of Uncertainty

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions of the world are always incomplete and our observations are limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, it is difficult to conduct experiments that produce clean results in the ecological sciences. Often, observations, inference, good thinking, and models must be relied

on to guide our understanding of ecological relations. Confronting uncertainty then is not prescriptive. In this assessment, the strength of evidence for particular ideas is noted, and alternative explanations are described when appropriate.

Because of a lack of extensive experimental research efforts concerning *Telesonix jamesii*, this assessment report relies heavily on the personal observations of botanists and land management specialists from throughout the species' range. Much of the knowledge about the biology and ecology of *T. jamesii* is based primarily on taxonomic studies (e.g., Gornall and Bohm 1985), unpublished species accounts (Johnston 2002, Colorado Natural Heritage Program 2004), and personal observations by botanists and resource management specialists (B. Johnston personal communication 2003, D. Anderson personal communication 2004, J. Connor personal communication 2004, S. Olson personal communication 2004). When information presented in this assessment is based on our personal communications with a botanist, we cite those sources as "personal communication". Unpublished data (e.g., NHP element occurrence records and herbarium records) were important in estimating the geographic distribution and describing the habitat of this species. These data required special attention because of the diversity of persons contributing to the records, the variety of methods used to collect the data, and unverified historical information. There is considerable uncertainty regarding location information and occurrences of this species on USFS lands.

In formulating this assessment, we also incorporated information from other Saxifragaceae species endemic to USFS Region 2 or adjacent states, where available. Any comparisons are not meant to imply that *Telesonix jamesii* is biologically identical to these other species, but they represent an effort to hypothesize about *potential* characteristics of this species. The biology, ecology, conservation, and management issues presented for this species in USFS Region 2 are based on inference from these published and unpublished sources. We clearly noted when we were making inferences based on the available knowledge to augment or to enhance our understanding of *T. jamesii*.

Publication of Assessment on the World Wide Web

To facilitate their use in the Species Conservation Project, species assessments will be published on the USFS Region 2 World Wide Web site. Placing

documents on the Web makes them available to agency biologists and the public more rapidly than publishing them as reports. More importantly, it facilitates their revision, which will be accomplished based on guidelines established by USFS Region 2.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to release on the Web. This assessment was reviewed through a process administered by the Center for Plant Conservation, employing at least two recognized experts on this or related taxa. Peer review was designed to improve the quality of communication and to increase the rigor of the assessment.

MANAGEMENT STATUS AND NATURAL HISTORY

Telesonix jamesii is a regional endemic species and is known from approximately 19 occurrences in Colorado and 2 unverified occurrences in Wyoming and New Mexico (**Figure 1, Table 1**; Fertig and Heidel 2002, New Mexico Natural Heritage Program 2003, University of Colorado Herbarium 2003, Washburn University Herbarium 2003, Colorado Natural Heritage Program 2004, Colorado State University Herbarium 2004, Kathryn Kalmbach Herbarium 2004). This section discusses the special management status, existing regulatory mechanisms, and biological characteristics of this species.

Management and Conservation Status

Federal status

Telesonix jamesii is not listed on the U.S. Fish and Wildlife Service (2004) (USFWS) threatened or endangered species list, the USFS Rocky Mountain Region sensitive species list (USDA Forest Service 2003), or the Colorado Bureau of Land Management (BLM) sensitive species list (Bureau of Land Management 2000).

Heritage program ranks

Heritage databases draw attention to species of special concern potentially requiring conservation strategies for future success. However, these lists are not associated with specific legal constraints, such as limiting horticultural collection or restricting damage to critical habitats. The global heritage status rank for *Telesonix jamesii* is G2G3 (between globally

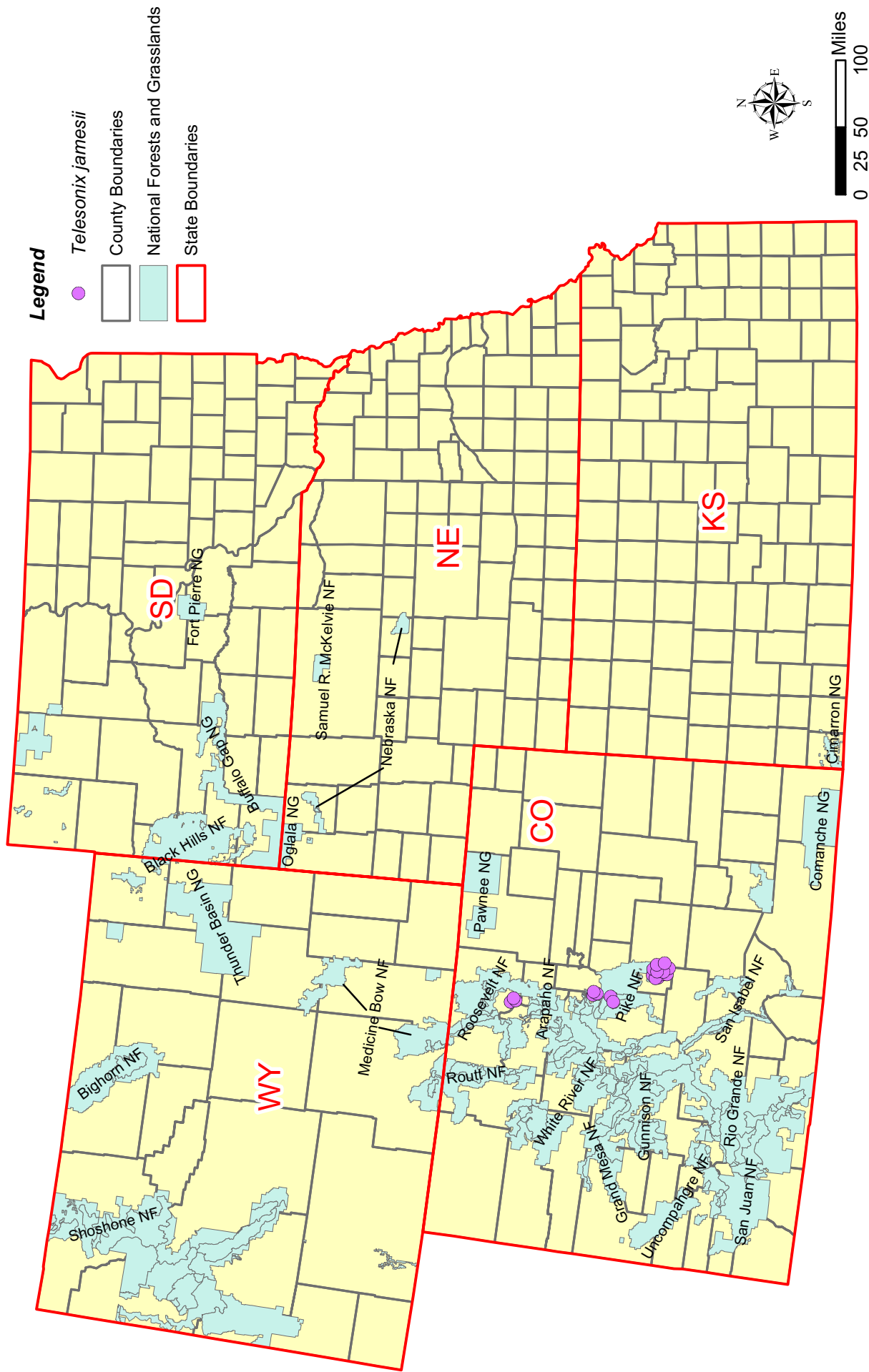


Figure 1. Map of U.S. Forest Service Region 2 illustrating distribution of *Telesonix jamesii* occurrences in El Paso, Jefferson, Larimer, Park, and Teller counties, Colorado. Each occurrence may include one to several populations. Refer to document for abundance information. Unverified occurrences from Albany County, Wyoming and San Miguel County, New Mexico are not included on this map. Sources: Fertig and Heidel (2002), New Mexico NHP (2003), University of Colorado Herbarium (2003), Washburn University Herbarium (2003), Colorado Natural Heritage Program (2004), Colorado State University Herbarium (2004), Kathryn Kalmbach Herbarium (2004), Rocky Mountain Herbarium (2004).

Table 1. Information on 19 *Telesonix jamesii* occurrences in Colorado (USFS Region 2). Two unverified occurrences from Wyoming (USFS Region 2) and New Mexico (outside USFS Region 2) are not included in this table. Table includes county, dates of observation, estimated abundance, land management context, elevation, habitat information, associated plant species, and element occurrence ranks. (?) – indicates uncertainty. **Key to element occurrence ranks:** A – excellent estimated viability; B – good estimated viability; H – historical (i.e., last observation is over 20 years ago) **Sources:** Fertig and Heidel (2002), New Mexico NHP (2003), University of Colorado Herbarium (2003), Washburn University Herbarium (2003), Colorado Natural Heritage Program (2004), Colorado State University Herbarium (2004), Kathryn Kalmbach Herbarium (2004), Rocky Mountain Herbarium (2004).

County, State	Date of Observations	Estimated Abundance	Management Area/Ownership	Elevation Range (ft)	General Habitat Description	Associated Plant Species	Element Occurrence Rank
El Paso, Colorado	1943	Plentiful	Pike-San Isabel National Forest	10,705	Plentiful around rock outcrops and in deep boulder pockets, partial shade, often on vertical faces of old boulders	<i>Saxifraga saximontana</i> , <i>Heuchera hallii</i>	H
	1943	Not Available (NA)	Pike-San Isabel National Forest; Colorado Bureau of Land Management; Private land	8,360 to 8,700	In decomposed granite gravels, about rock outcrops at head of steep canyon, shaded by rocks only	Not Available (NA)	H
	1906, 1914	NA	Pike-San Isabel National Forest; Colorado Bureau of Land Management, State of Colorado; U.S. Department of Defense; Private land	6,800 to 13,000	Not Available (NA)	NA	H
	1935, 1998, 2000	Hundreds, probably more (1998); hundreds (2000)	Pike-San Isabel National Forest	9,600	Along boulders and cracks of granite in Douglas-fir forest; under and around boulders; cliff	<i>Ribes</i> spp., <i>Rubus</i> spp., <i>Jamesii americana</i> , <i>Physocarpus</i> spp., <i>Heuchera</i> spp., <i>Pseudotsuga menziesii</i> , <i>Juniperus communis</i> , <i>Pinus aristata</i> , <i>Ciliaria montana</i>	B
	2000	Tens of thousands	Pike-San Isabel National Forest	12,120 to 13,600	Festooning the walls of the cirque, in cracks in granite; near the floor of the cirque it also grows next to stabilized boulders; south-east-north aspects; 0 to 100 percent slopes; xeric moisture; full sun to part shade light exposure; pink granite parent material; alpine fellfield	<i>Aquilegia saximontana</i> , <i>Cirsium scopulorum</i> , <i>Bistorta bistortoides</i> , <i>Bistorta vivipara</i> , <i>Rhodiola integrifolia</i> , <i>Saxifraga rhomboidea</i> , <i>Mertensia alpina</i> , <i>Silene acaulis</i> , <i>Minuartia obtusiloba</i> , <i>Pentaphylloides floribunda</i> , <i>Paronychia pulvinata</i> , <i>Ciliaria montana</i> , <i>Campanula uniflora</i> , <i>Hirculus platysepalus</i> ssp. <i>crandallii</i> , <i>Hirculus serpyllifolius</i>	A
	2000	500	Pike-San Isabel National Forest; Private land	12,700 to 13,050	Glacially carved cliff; alpine cliff/rock outcrop; on vertical faces in cracks and on flat benches; southeast aspect; 0 to 90 percent slopes; xeric; full sun light exposure; pink granite parent material; gravelly soil	Associates in rock cracks: <i>Aquilegia saximontana</i> ; associates on benches: <i>Aquilegia saximontana</i> , <i>Silene acaulis</i> , <i>Mertensia alpina</i> , <i>Kobresia myosuroides</i> , <i>Oreoxis humilis</i> , <i>Trifolium nanum</i> , <i>Acomastylis rossii</i>	A

Table 1 (cont.).

County, State	Date of Observations	Estimated Abundance	Management Area/ Ownership	Elevation Range (ft)	General Habitat Description	Associated Plant Species	Element Occurrence Rank
Larimer, Colorado	1966, 1970, 1987	Abundant (1987)	Rocky Mountain National Park	8,840 to 9,000	Rock crevice and on rock face directly above water; south facing slope; in crevices on west-facing granite outcrops	<i>Heuchera bracteata</i> , <i>Saxifraga bronchialis</i> , <i>Jamesia americana</i> , <i>Mertensia lanceolata</i> , <i>Draba streptocarpa</i>	Not Available (NA)
	1960	NA	Rocky Mountain National Park	8,700	NA	NA	NA
	1938	NA	Rocky Mountain National Park	Not Available (NA)	NA	NA	NA
Jefferson, Colorado	1992, 1999	3,000 (1999)	Private land (?); Pike-San Isabel National Forest (?)	9,400 to 10,680	Growing in cracks on cliffs, boulders fields, and in granitic gravel; large outcrops of pink granite; cliffs of granite reach hundreds of feet in height; all aspects; 0 to 90 degree slopes; full sun, part shade, full shade light exposure; mesic and xeric; granite parent material; granitic gravelly loam soil; coniferous forests (Engelmann spruce, lodgepole pine and limber pine and patches of aspen), <i>Jamesia americana</i> shrublands, and mat forming plants on cliffs	<i>Heuchera bracteata</i> , <i>Saxifraga bronchialis</i> , <i>Jamesia americana</i> , <i>Mertensia lanceolata</i> , <i>Draba streptocarpa</i> , mosses	A
	1999	NA	State of Colorado (Staunton State Park)	9,400	Cliffs/rock outcrops; on pink granite outcrops in organic soils that have accumulated in cracks; surrounding forest is dominated by limber pine, lodgepole pine, Douglas-fir; rock outcrops are hundreds of feet tall; all aspects; vertical slopes; part shade light exposure; mesic; granite parent material and gravelly loam soils; inaccessible cliff face	<i>Jamesia americana</i> , <i>Holodiscus discolor</i> , <i>Erigeron vetensis</i> , lichen	B
	1976	Locally abundant	Private land; Pike- San Isabel National Forest (?)	7,500	On tors of Pikes Peak granite, lower slopes of rock outcrop	NA	NA
Park, Colorado	1999	700, 3 sub- element groups (100-500 each) (?)	State of Colorado (Staunton State Park); Private land (?)	8,320 to 9,460	Rock outcrops, pinnacles, and cliffs; cliff faces of pink granite rock outcrops; cliff face with mixed conifer forest (limber pine, ponderosa pine, spruce); cliffs in an open mixed coniferous forest (limber pine, Douglas-fir, Engelmann spruce, <i>Jamesia americana</i>); in creek valley with mixed coniferous forests (<i>Pinus ponderosa</i> , <i>Pinus flexilis</i> , <i>Pseudotsuga menziesii</i>), lithophyllic community, riparian communities, and large wetland area; all aspects; 0 to 90 degree slopes; full sun, part shade, and full shade light exposure; mesic and xeric; pink granite parent material; inaccessible cliff face; sandy and granitic gravelly loam soils	<i>Heuchera</i> spp., <i>Heuchera bracteata</i> , <i>Saxifraga bronchialis</i> , <i>Asplenium septentrionale</i> , <i>Fragaria virginiana</i> , <i>Drymocalis</i> spp., <i>Ciliaria austromontana</i> , mosses, lichens	A

Table 1 (concluded).

County, State	Date of Observations	Estimated Abundance	Management Area/ Ownership	Elevation Range (ft)	General Habitat Description	Associated Plant Species	Element Occurrence Rank
Park, Colorado	1979	NA	Pike-San Isabel National Forest (Lost Creek Wilderness)	10,900	Growing in cracks on granite tor	NA	NA
Teller, Colorado	1995, 1998	Hundreds, more expected over whole summit (1998)	Pike-San Isabel National Forest; Private land	11,600 to 12,500	On boulder outcrops in bristlecone and Engelmann spruce krummholz and tundra; 0 to 40 degree slopes; granitic soils	<i>Geum</i> spp., <i>Bistorta</i> spp., <i>Castilleja</i> spp., <i>Kobresia</i> spp., <i>Phlox</i> spp., <i>Trifolium</i> spp., <i>Artemisia</i> spp., <i>Gentian</i> spp., <i>Penstemon</i> spp., <i>Mertensia alpina</i> , <i>Potentilla</i> spp., <i>Stellaria</i> spp., <i>Tolmiechevia</i> spp., <i>Erigeron pinnatisectus</i>	A
	1912, 1998	Hundreds, more expected along whole ridge (1998)	Pike-San Isabel National Forest; Private land	10,000 to 12,319	Alpine ridges; large boulder granite outcrops; on a hill totally covered in a boulder field of some stage of granite	No associates	A
	1954	NA	Private land (?); Colorado Division of Wildlife (Pikes Peak State Wildlife Area) (?)	10,597 to 11,299	Base of rocks	NA	NA
Teller/El Paso, Colorado	1887, 1898, 1931, 1943, 1962, 1998	One plant (1943); hundreds of plants, probably more (1998)	Pike-San Isabel National Forest	11,500 to 13,000	Above timberline and within krummholz on granite gravel slopes and within granite boulder outcrops; 0 to 60 degree slopes; full sun exposure	<i>Hirculus platysepalus</i> ssp. <i>crandallii</i> , <i>Mertensia alpina</i> , <i>Claytonia</i> spp., <i>Noccea</i> spp., <i>Selaginella</i> spp., <i>Micranthes</i> <i>rhomboidea</i> , <i>Oreoxis humilis</i> , <i>Eritrichium aretioides</i> , <i>Allium</i> spp., <i>Stellaria</i> spp., <i>Androsace</i> <i>chamaejasme</i> ssp. <i>carinata</i> , <i>Bistorta</i> spp., <i>Geum rossii</i> , <i>Trifolium nanum</i> , <i>Phlox</i> spp., <i>Cirsium scopulorum</i> , <i>Artemisia</i> spp., <i>Castilleja</i> spp., <i>Sibbaldia</i> spp., <i>Pedicularis</i> spp.	A
Unknown, Colorado	1926	NA	NA	NA	NA	NA	NA

imperiled and globally vulnerable; D. Anderson personal communication 2004, Colorado Natural Heritage Program 2004). The Colorado NHP ranks this species as S2 (imperiled in state because of rarity [6 to 20 occurrences] or because of factors demonstrably making a species vulnerable to extinction; D. Anderson personal communication 2004, Colorado Natural Heritage Program 2004). The Wyoming Natural Diversity Database (WYNDD) noted that *T. jamesii* has been reported in the state, but its status is uncertain (Fertig and Heidel 2002). “Uncertain status” species may warrant conservation efforts, but they are not yet listed as species of special concern due to uncertainties regarding taxonomy, identification, or confirmed occurrences in the state. *Telesonix jamesii* is not known from Kansas, Nebraska, or South Dakota and is thus not currently listed or ranked in those states (Kansas Natural Heritage Inventory 2002, Nebraska Natural Heritage Program 2002, South Dakota Natural Heritage Program 2002). Outside of Region 2, *T. jamesii* is ranked as “S?” in New Mexico, which indicates that the rank is not yet assessed there. The species is not currently tracked by the New Mexico Natural Heritage Program (New Mexico Natural Heritage Program 2003).

Telesonix heucheriformis is a closely-related species (see discussion in Systematics and synonymy section) that has been considered as *T. jamesii* (sensu lato) in some treatments (e.g., Cronquist et al. 1997); we provide information about heritage program ranks of *T. heucheriformis* to clarify differences between these two species. The distribution of *T. heucheriformis* includes Idaho, Montana, Nevada, South Dakota, Utah, Wyoming, and Alberta (NatureServe 2004). *Telesonix heucheriformis* has a global heritage status rank of G4 (apparently secure globally) because it is apparently widespread. State (or provincial) ranks for *T. heucheriformis* include S1 (critically imperiled in state) in Utah, S2 (imperiled in state) in Alberta, S3 (vulnerable in state) in Wyoming, and SNR (not ranked) in Idaho, Montana, Nevada, and South Dakota (NatureServe 2004).

Existing Regulatory Mechanisms, Management Plans, and Conservation Practices

The majority of information about *Telesonix jamesii* is contained within brief descriptions associated with herbarium specimens or element occurrence records, often with very little specific location information. Therefore, there is considerable uncertainty regarding the exact location of many sites and occurrence of those populations on USFS lands; inferences are made

from location descriptions and mapping exercises. When insufficient information exists to make a certain determination, the land management context is associated with a “(?)” on **Table 1**. In addition, each location may include several populations over a slope or ridge, and in some cases several records are considered as one occurrence. In these cases, some occurrences may extend over several adjacent land management areas (e.g., USFS and adjacent private lands). There have been many historical collections of *T. jamesii* from Pikes Peak. It is impossible to determine from existing information if these collections were from the same occurrence (or sub-occurrence) and how many occurrences (or sub-occurrences) may exist on Pikes Peak.

Known populations of *Telesonix jamesii* occur in a variety of land ownership and management contexts. Currently, 12 of the 19 known occurrences of this species in Colorado may occur entirely or partly on USFS Region 2 lands, specifically the Pike-San Isabel National Forest (**Table 1**). Additional occurrences are entirely or partly on National Park Service lands (Rocky Mountain National Park), State of Colorado lands (Staunton State Park, Colorado Division of Wildlife State Wildlife Area), Colorado BLM lands, U.S. Department of Defense lands, private lands, or lands of unknown ownership (**Figure 1**, **Table 1**). Within the Pike-San Isabel National Forest, one occurrence may possibly occur within the Lost Creek Wilderness Area. The remainder of USFS, NPS, BLM, and State of Colorado occurrences is probably on lands managed for multiple use with an effort to prevent damage to populations of species of special concern. The management of any plants on private lands is unknown.

Although *Telesonix jamesii* has been identified as a species of special concern, there are no species-specific regulatory mechanisms at the federal or state level to manage its conservation. This species is not currently designated as a USFS Region 2 sensitive species but still may obtain protection from various conservation strategies designed to protect plants and animals on federal lands. While managing lands for multiple use, USFS policy is to develop and implement management practices that ensure that sensitive species do not become threatened or endangered (USDA Forest Service 1995). The National Environmental Policy Act (U.S. Congress 1982) requires an assessment of impacts of any significant federal projects to natural environments. In addition, the National Park Service (NPS) prohibits the collection of any native plants without permit (USDI National Park Service 2002a), and the USFS prohibits the collection of sensitive plant species without a permit (USDA Forest Service 1995).

Examples of specific management plans to reduce negative impacts to species of concern on federal and state lands in Colorado include the *Pikes Peak Multi-Use Plan* (Pikes Peak) (Design Workshop, Inc. 1999), a drainage, erosion, and sediment control plan for the Pikes Peak highway (J. Hovermale personal communication 2004); *Environmental Assessment for the Relocation of Twin Owls and Gem Lake Trailheads* (in Rocky Mountain National Park) (USDI National Park Service 2002b); and a pre-development field survey for Staunton State Park (Spackman and Anderson 1999). The *Pikes Peak Multi-Use Plan* developed by the USFS and Colorado Springs Utilities outlines the protection of natural resources within watersheds of the Pikes Peak area. While this plan does not specifically mention *Telesonix jamesii*, it does outline plans to pave the Pikes Peak toll road to reduce sedimentation and to minimize trail creation to reduce trampling impacts on fragile tundra communities (Design Workshop, Inc. 1999). Operation and maintenance of the Pikes Peak toll road is accomplished by the City of Colorado Springs under a special use permit with the USFS, and Pikes Peak Highway paving is associated with legal settlements and congressional mandates to protect watersheds in the Pikes Peak area (J. Hovermale personal communication 2004). An environmental assessment examined the effects of the proposed sediment control actions, and a finding of no significant impact was signed in 2000 (J. Hovermale personal communication 2004). Paving of the Pikes Peak toll road started in 2001 and continues as part of a 12-year project (J. Hovermale personal communication 2004). In Rocky Mountain National Park, *T. jamesii* was not found on lands that will be directly affected by the Twin Owls and Gem Lake Trailhead relocations, but the area is near occurrences for this species and future surveys will be conducted if land management changes (USDI National Park Service 2002b, J. Connor personal communication 2004). Denver Botanic Gardens performed an inventory of species of special concern in Rocky Mountain National Park to identify potential threats, but the study did not include *T. jamesii* (J. Connor personal communication 2004). However, there are tentative plans to revisit *T. jamesii* sites in 2004 to assess population size and to identify any significant threats to this species (e.g., trampling by trail users, horticultural collection) (J. Connor personal communication 2004). Steps would then be taken to protect specific populations (J. Connor personal communication 2003). Staunton State Park is scheduled to open to the public in 2006, and Colorado Division of Parks and Recreation is currently developing a master plan to address recreation and resource management needs (Colorado Mountain Club 1999, Stein 2004). The Colorado NHP performed

a field survey of the park to inventory plant resources and identified the location of *T. jamesii* populations (Spackman and Anderson 1999). As a result, the management plan will likely consider the presence of this and other rare species (e.g., *Mimulus gemmiparus*) when creating land use plans (D. Anderson personal communication 2004).

Existing regulations do not appear to be adequate to conserve *Telesonix jamesii* over the long term, considering that the details of its abundance and spatial distribution are not well known and specific populations may be threatened by a variety of human-related and ecological threats.

Biology and Ecology

Classification and description

Systematics and synonymy

Telesonix jamesii (Torrey) Rafinesque is one of the two members of the genus *Telesonix* of the group *Boykinia* in family Saxifragaceae (Saxifragales), order Rosales, and group Dicotyledonae (dicots) of phylum Anthophyta (flowering plants) (Kartesz 1999, MacBryde 2000, USDA Natural Resources Conservation Service 2002, NatureServe 2004). Common names include James' telesonix, James' brookfoam, James' false saxifrage, and Boykinia (New Mexico Natural Heritage Program 2003).

There has been some confusion concerning the taxonomic placement of *Telesonix jamesii* within Saxifragaceae as well as its relationship to a closely related taxon, *T. heucheriformis*. In previous treatments, *T. jamesii* has been considered as *Saxifraga jamesii* (Torrey 1827, Harrington 1954), *T. jamesii* (Rafinesque 1837), *B. jamesii* var. *jamesii* (Gornall and Bohm 1980), *B. jamesii* (Engler 1930, Gornall and Bohm 1985), *T. jamesii* var. *jamesii* (Bacigalupi 1947, Cronquist et al. 1997), and *T. jamesii* (sensu stricto) (Kartesz 1999). *Telesonix heucheriformis* has been treated as *B. jamesii* var. *heucheriformis* (Gornall and Bohm 1980), *B. heucheriformis* (Gornall and Bohm 1985), *T. jamesii* var. *heucheriformis* (Cronquist et al. 1997), and *T. heucheriformis* (Kartesz 1999).

Torrey (1827) presented this species as *Saxifraga jamesii*, Engler (1930) treated it as *Boykinia jamesii*, and Rafinesque (1837) placed it into a new genus, *Telesonix*. Gornall and Bohm (1980) did extensive taxonomic work with the family Saxifragaceae using flavonoid chemistry, and their work supported the exclusion of

this species from the genus *Saxifraga* and its placement into the genus *Boykinia*. Although the researchers placed this species into the genus *Boykinia*, they also suggested that the species could possibly belong in the genus *Telesonix* (Gornall and Bohm 1980). Gornall and Bohm (1980) noted that *B. jamesii* var. *jamesii* and *B. jamesii* var. *heucheriformis* had similar flavonoid profiles, but emphasized that there was insufficient amount of material available to adequately assess all of the compounds in *B. jamesii* var. *jamesii*. If certain compounds were determined to be absent from *B. jamesii* var. *jamesii*, then it would support the recognition of the varieties at a specific level. Gornall and Bohm (1985) used information about flavonoid chemistry and chromosome numbers in conjunction with morphological comparisons (e.g., leaf anatomy, trichomes, pollen grains, and seeds) to publish a monograph of *Boykinia* in 1985. In this work, Gornall and Bohm (1985) separated *B. jamesii* (sensu lato) into two distinct species, *B. jamesii* and *B. heucheriformis* on the basis of flavonoid profile, pollen morphology, and morphological differences. However, Gornall and Bohm (1985) emphasized that these two species should be placed in *Boykinia*, and not *Telesonix*, due to the shared flavonoid profile with other *Boykinia* species and successful experimental hybridization of *B. heucheriformis* with *B. occidentalis*. Molecular studies (cpDNA restriction site data and *rbcL* sequences) by Soltis et al. (1993) supported the placement of these two species into *Telesonix*. These molecular studies and observed morphological differences between these two species and the rest of the *Boykinia* species (also noted by Gornall and Bohm 1985) convinced Cronquist et al. (1997) to retain these two species in the genus *Telesonix* and not in *Boykinia*. *Telesonix* species differ morphologically from *Boykinia* species by a simpler inflorescence structure, smooth seeds, colpoidate pollen, 10 stamens, purple flowers, and chasmophytic habit (Gornall and Bohm 1985, Cronquist et al. 1997). Cronquist et al. (1997) included these two taxa in the *Telesonix* genus but treated them as varieties within *T. jamesii* (sensu lato) based on intermediate specimens found in central and western Wyoming. In contrast, Kartesz (1999) presented these two taxa as separable, distinct species within the genus *Telesonix*. This species assessment also treats these two taxa as distinct species and presents natural history and conservation information for *T. jamesii* (sensu stricto).

History of species

Telesonix jamesii was first collected by Edwin James on July 14, 1820 on Pikes Peak (Goodman and Lawson 1995), and John Torrey described this species as *Saxifraga jamesii* in 1827, naming it for

the collector (Weber and Wittmann 2001). An isotype specimen for this species is housed at the University of Colorado Herbarium (2003). As described above, the members of the family Saxifragaceae, including *Telesonix*, have been subject to considerable taxonomic and phylogenetic debate (Gornall and Bohm 1980, Gornall and Bohm 1985, Soltis et al. 1993, Cronquist et al. 1997, Soltis et al. 2001). However, there have been no conservation efforts focusing on *T. jamesii* as an endemic species. This is likely due to the fact that *T. jamesii* has been combined with the more widespread *T. heucheriformis* in some accounts and was thus not considered extremely rare. There is an unpublished status evaluation focusing on *T. jamesii* (Johnston 2002), but no quantitative demographic, ecological, or biological studies of this species have been undertaken.

Morphological characteristics

Members of the family Saxifragaceae are characterized by simple leaves, actinomorphic flowers with four to five sepals and four to five petals, and a perennial habit (Harrington 1954). The name “Saxifragaceae” means “breaker of rocks”, and many saxifrages are found in crevices and other rocky habitats (Nelson 1992).

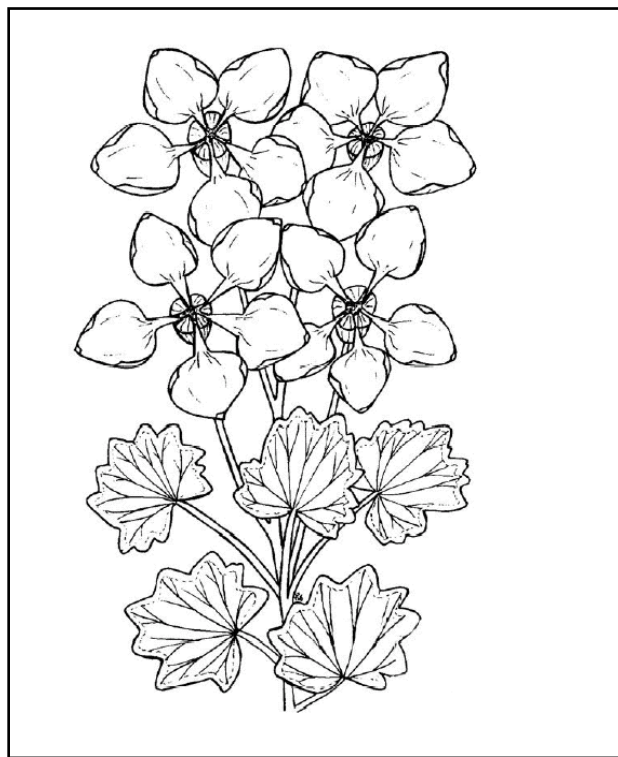
Telesonix jamesii is a perennial herb from 60 to 180 millimeters (mm) tall with a thick, scaly, branched rhizome (**Figure 2**; Gornall and Bohm 1985, Cronquist et al. 1997). There are one to several densely glandular, erect, flowering stems. The petiolate basal leaves are reniform, cuneate to cordate in shape, and from 10 to 55 mm long by 14 to 70 mm wide. The leaf margins are doubly crenate to shallowly lobed and crenate-dentate. The leaves are also succulent and glandular-pubescent with stomata on the upper surface. The leaf petioles have stipules 0.5 to 2.0 mm long, often with whitish bristles. Cauline leaves are few and get progressively smaller and less petiolate up the stem. The glandular-pubescent inflorescence is comprised of a compact, often secund panicle with 5 to 20 showy, perfect, regular flowers, leafy bracts, and reddish axis and branches. The campanulate flowers are comprised of five lanceolate sepals 2 to 6 mm long, five crimson-purple petals 6 to 11 mm long and 2.5 to 7 mm wide, and a free hypanthium 1 to 2 mm long. The entire petals are cuneate to long-clawed. This species has 10 stamens, shorter or equal to sepals in length, with anthers 0.7 to 1.9 mm long. The fruit is a two-beaked urceolate capsule. The capsules dehisce to release small seeds, from 880 to 1380 micrometers (μm) long. The dark brown seeds are oblong, smooth, shiny, and lack tubercles.

(A)



Photographs by W.A. Weber (left) and H.D. Roberts (right), used with permission of the University of Colorado Museum Herbarium.

(B)



Adapted from Dawson, C., A. Kratz, R. Garfias, T. TGrant, and C. Spurrier. 1999. Wildflowers of the Colorado Mountain Tops Coloring Book. Illustrations by Karl Urban and Janet Wingate. Prepared for the Native Plant Conservation Initiative.

Figure 2. *Telesonix jamesii* (A) photographs in its natural habitat in Colorado, and (B) illustration of the vegetative and reproductive structures.

Telesonix jamesii and *T. heucheriformis* are closely related species with distinct morphological differences in flower structure (Gornall and Bohm 1985, Cronquist et al. 1997). *Telesonix jamesii* flowers have crimson-purple petals that tend to be orbicular in shape and 6 to 11 mm long and 2.5 to 7 mm wide. The styles of *T. jamesii* are generally connate for at least three-quarters of their length. In contrast, *T. heucheriformis* flowers have violet-purple petals that tend to be ovate in shape and much smaller, 2.5 to 6 mm long and 1 to 3 mm wide. The petals of *T. heucheriformis* are usually subequal to or barely exceed the sepals. The styles of *T. heucheriformis* tend to be connate for only half of their length. *Telesonix jamesii* differs from closely related *Boykinia* species because *Telesonix* species have 10 stamens, a simpler inflorescence, and smooth seeds (Gornall and Bohm 1985).

Technical descriptions of *Telesonix jamesii* are presented in Gornall and Bohm (1985) and Cronquist et al. (1997). Photographs and illustrations are available in Yeatts and Wingate (1985).

Distribution and abundance

Telesonix jamesii is a regional endemic species and is known from approximately 21 occurrences globally, including two unverified occurrences (**Figure 1, Table 1**; Fertig and Heidel 2002, New Mexico Natural Heritage Program 2003, University of Colorado Herbarium 2003, Washburn University Herbarium 2003, Colorado Natural Heritage Program 2004, Colorado State University Herbarium 2004, Kathryn Kalmbach Herbarium 2004). Within USFS Region 2, this species is found only in the southern Rocky Mountains of Colorado and possibly Wyoming. Outside of USFS Region 2, this species is recorded, but unverified, from northern New Mexico (Cronquist et al. 1997, Johnston 2002).

Other records of *Telesonix jamesii* from states outside USFS Region 2 (e.g., Idaho, Montana) are based on the historical use of the name *T. jamesii* sensu lato as inclusive of both *T. jamesii* var. *jamesii* and *T. jamesii* var. *heucheriformis*. The records of *Telesonix* species in those states are probably the more widespread *T. heucheriformis* although specimens have not been critically examined by experts in all cases to verify that assumption (S. Crispin personal communication 2003, M. Mancuso personal communication 2003).

In Colorado, *Telesonix jamesii* is distributed in north-central and central Colorado, along the easternmost Front Range from Rocky Mountain

National Park south to Pikes Peak (**Figure 1, Table 1**; Roberts and Nelson 1957, Nelson 1970, Weber and Wittmann 2001, University of Colorado Herbarium 2002, Colorado Natural Heritage Program 2004). The distribution includes Larimer, Jefferson, Park, Teller and El Paso counties (**Figure 1**). Colorado NHP (2004) element occurrence records do not include any records from Larimer County, but the University of Colorado Herbarium (2002) houses two specimens from the Gem Lake Trail in Rocky Mountain National Park and Nelson (1970) mentions the presence of this species in the park. Packer and Vitt (1974) report *T. jamesii* from Albany County in southern Wyoming, but this occurrence is not substantiated with an herbarium specimen and has not been verified (B. Johnston personal communication 2003, B.E. Nelson personal communication 2003). However, B. Johnston (personal communication 2003) believes that it is “within the realm of possibility” for *T. jamesii* to be found in southern Wyoming because suitable habitat exists in that portion of the southern Rocky Mountains. The record of *T. jamesii* located in Park County, Wyoming, as portrayed in the online *Atlas of the Vascular Flora of Wyoming*, is a data input error (B. Johnston personal communication 2003, B.E. Nelson personal communication 2003). *Telesonix jamesii* does not occur in Kansas, Nebraska, or South Dakota and is thus not currently listed or ranked in those states (Kansas Natural Heritage Inventory 2002, Nebraska Natural Heritage Program 2002, South Dakota Natural Heritage Program 2002). The only record of *T. jamesii* outside USFS Region 2 is reported from Solitario Peak in San Miguel County, New Mexico, but this occurrence has not been verified with a specimen (Cronquist et al. 1997, MacBryde 2000, J. Mygatt personal communication 2003, B. Sivinski personal communication 2003).

The only records of *Telesonix jamesii* abundance in USFS Region 2 are from element occurrence records and herbarium specimen labels (Colorado Natural Heritage Program 2004, University of Colorado 2004). Because of the clump-forming growth habit, the rugged terrain, and cliff habitat of this species, observers found it difficult to estimate the number of individuals. In many cases, the observers reported that the areas were not thoroughly searched and that *T. jamesii* may be more prevalent than documented. Technical rock-climbing gear would be necessary to reach some populations of this species. In addition, the clumps of individuals are scattered over a large area, and each occurrence could include several sub-element occurrences or populations. For example, it is possible that *T. jamesii* could occur “over whole summit” of Pikes Peak, but the full spatial extent of this occurrence or number of sub-occurrences is not clear from this description.

The reported abundance of *Telesonix jamesii* occurrences ranges from descriptions such as “plentiful” to “abundant” and quantified observations such as 100 to “hundreds” to 3,000 to “tens of thousands”. Refer to **Table 1** for available abundance information for each occurrence. “It appears to be common within its restricted range of habitats, with large to very large populations.” (Johnston 2002). It is probable that population sizes have been underestimated (Johnston 2002, Colorado Natural Heritage Program 2004). Johnston (2002) estimates that there may be 50 populations and perhaps 100,000 individuals. Element occurrence ranks based on observer judgment of *T. jamesii* occurrence size and landscape context include seven A-ranked occurrences (excellent estimated viability), two B-ranked occurrences (good estimated viability), and three H-ranked occurrences (historical; last observation is over 20 years ago) (Colorado Natural Heritage Program 2004). The remaining seven occurrences have not been ranked by the Colorado NHP, but based on observation dates, these occurrences could also be considered historical (i.e., last observation is over twenty years ago).

Population trends

There are no data on population trends for *Telesonix jamesii*. Although population sizes have been estimated in some cases, multi-year population or demographic monitoring has not been initiated for any site. Johnston (2002) made some repeated observations of a few populations and did not see signs of decline.

Habitat characteristics

Telesonix jamesii is a perennial plant that grows on granite outcrops in montane, subalpine or alpine environments of the southern Rocky Mountains in Colorado and possibly Wyoming and New Mexico. The only descriptions of *T. jamesii* habitat are available from Colorado NHP element occurrence records; there are no habitat descriptions from unverified occurrences in New Mexico or Wyoming.

Telesonix jamesii grows in a variety of rocky microhabitats, including cracks and ledges on cliff faces reaching hundreds of feet high; in boulderfields and on talus/scree/gravel slopes below cliffs; on and around old boulders and granite tors; and on rock outcrops in canyons and on ridges. The elevation of these sites ranges widely, from 1,830 to 3,980 meters (m) (6,000 to 13,050 feet [ft]). Slopes are from 0 to 100 percent; aspect includes all directions; light exposure is from full sun to part shade to full shade; and moisture levels

range from mesic to xeric. Gornall and Bohm (1985) reported that both *T. jamesii* and *T. heucheriformis* are usually found in open environments, although there can sometimes be a partial canopy of coniferous tree species. The researchers also hypothesized that the succulent leaves of *T. jamesii* may be related to the exceedingly dry habitat in which it can be found (Gornall and Bohm 1985). The parent material of the Front Range physiographic province is generally comprised of exposed granites (e.g., Pikes Peak granite), gneisses, and schists of Precambrian origin (Chumley 1998). The decomposed granitic soils of these microhabitats are granitic gravels, gravelly loams, sandy loams, or small amounts of organic soils that have accumulated in the cracks of outcrops.

The ecological communities where *Telesonix jamesii* grows can be alpine tundra and fellfields, hanging gardens or rocky ledge communities, mixed conifer forests and krummholtz, or shrubfields (Colorado Natural Heritage Program 2004). Depending on elevation and location, the dominant overstory vegetation could be mixed coniferous forests with species such as *Pinus flexilis* (limber pine), *Pinus contorta* (lodgepole pine), *Pseudotsuga menziesii* (Douglas-fir), *Pinus aristata* (bristlecone pine), and *Picea engelmannii* (Engelmann spruce) (e.g., II.A.4.N.a.39 *Pinus aristata* Woodland Alliance); subalpine parklands, including *Pinus ponderosa* (ponderosa pine) and *Populus tremuloides* (aspen) (e.g., II.A.4.N.a.32 *Pinus ponderosa* Woodland Alliance); or *Jamesia americana* (shrubby fields with waxflower), *Ribes cereum* (currant), and *Rubus deliciosus* (raspberry) (e.g., CEG002783 *Jamesia americana* Rock Outcrop Shrubland) (Whitfield 1933, Chumley 1998, Grossman et al. 1998).

Telesonix jamesii appears to be consistently associated with other species commonly found growing on rocky outcrops, such as *Aquilegia* spp., *Erigeron* spp., *Heuchera* spp., *Saxifraga* spp., *Silene* spp., mosses, and lichens (Colorado Natural Heritage Program 2004). Refer to **Table 1** for a list of species associated with *T. jamesii* at each occurrence, where available.

Telesonix heucheriformis is found in rock crevices on calcareous substrates (e.g., limestone cliffs) in subalpine and alpine habitats at elevations from 1,500 to 3,500 m (4,921 to 11,483 ft.) (Gornall and Bohm 1985, Idaho Conservation Data Center 2003). Plant species observed with this taxon in Idaho include *Smelowskia calycina*, *Saxifraga oppositifolia*, and *Draba lonchocarpa* (Idaho Conservation Data Center 2003).

Reproductive biology and autecology

Reproduction

The reproductive systems of *Telesonix jamesii* (and the closely-related *T. heucheriformis*) have only been briefly described as a result of horticultural and taxonomic work (Gornall and Bohm 1985). In an effort to elucidate potential reproductive mechanisms for *T. jamesii*, we present information mainly from other rare, alpine, mat-forming species in the family Saxifragaceae, especially well-studied genera like *Saxifraga*. The genus *Saxifraga* is characterized by a wide variety of reproductive strategies, including a range of sexual/asexual strategies, self-compatible/cross-pollinated systems, and diploid/polyploid levels. A mixed mating system may be common and advantageous in the diverse arctic environments in which many of these *Saxifraga* live (Brochmann and Hapnes 2001). Gornall and Bohm (1985) noted that most species of *Boykinia* (*Telesonix*) are self-compatible to varying degrees.

Telesonix jamesii generally flowers from July to August and fruits in August (MacBryde 2000). This species produces small, smooth seeds. Although *T. jamesii* has thick, scaly rhizomes (Gornall and Bohm 1985) and appears to reproduce vegetatively (Colorado Natural Heritage Program 2004), there is no information concerning the extent of vegetative or sexual reproduction in the field. In general, perennial species in alpine habitats reproduce both vegetatively and sexually in order to take advantage of the resources and protection from the parent plant, especially when conditions are not conducive to sexual reproduction (Grime 1979, Zwinger and Willard 1996). There were two element occurrence records with observations about reproductive status. These records reported that there were multiple size classes, plants were producing fruits, and reproductive success of *T. jamesii* appeared to be high (Colorado Natural Heritage Program 2004). Depending on the month of observation, flowering percentages of *T. jamesii* populations ranged from 5 to 90 percent, as recorded in these two element occurrence records (and sub-occurrence records). Refer to the following sections for further information: Life history and strategy, Pollinators and pollination ecology, and Dispersal mechanisms.

Life history and strategy

There have been no studies on the life history, demographic rates, fecundity, or longevity of *Telesonix jamesii*. It is a perennial forb that grows close to the substrate in sparsely vegetated, exposed alpine

environments. *Telesonix jamesii* could possibly be considered an s-selected, or stress-tolerant species, because of its perennial life history and its ability to withstand unproductive conditions (Grime 1979, Barbour et al. 1987). The hypothesized life cycle of this perennial plant is depicted in **Figure 3**.

Many alpine plants share similar strategies and adaptations to extreme environmental conditions and a short growing season (Grime 1979, Zwinger and Willard 1996). Many alpine plants, including *Telesonix jamesii*, have a perennial life history because the short growing season precludes annual plants from producing stems, leaves, flowers, and fruit in a few months. Using food reserves stored underground in roots allows alpine perennials to flower early in the season and take advantage of the short summer heat to ripen seeds. In addition, many alpine plants have extended growth patterns where it may take many years for a plant to grow, produce buds, and eventually flower and set seed.

The morphology of *Telesonix jamesii* and other alpine plants helps to increase survival in extreme conditions such as cold temperatures, desiccating winds, intense solar radiation, and low moisture (Grime 1979, Zwinger and Willard 1996). These conditions can be especially intense in *T. jamesii* habitat, which can include fellfields, cliff faces, and gravelly slopes with dry soils and sparse plant cover. When growing on cliff faces, this species must adapt to environmental conditions such as high water runoff and intense exposure to solar radiation and wind. The relatively low growth form of *T. jamesii* may help to keep it out of harsh winds, reduce plant tissue growth needs, create less distance to transport water, allow interception of both solar radiation and ground-reflected radiation, and afford protection to the inner parts of the plant. The clump-forming growth can also cause accumulation of organic matter to help retain moisture. Many alpine plants grow extensive roots in order to anchor themselves in strong winds and to exploit precious moisture. *Telesonix* spp. leaves are succulent, and the stomata are commonly found on the upper leaf surfaces, a characteristic that is often correlated with life in open, xeric habitats (Gornall and Bohm 1985). The pubescent stem and leaf tissue of *T. jamesii* also helps to prevent water loss, protect against damaging solar radiation, and trap heat radiation (Zwinger and Willard 1996).

Pollinators and pollination ecology

Pollination biology and specific pollination mechanisms for *Telesonix jamesii* have not been studied. Gornall and Bohm (1985) noted that most

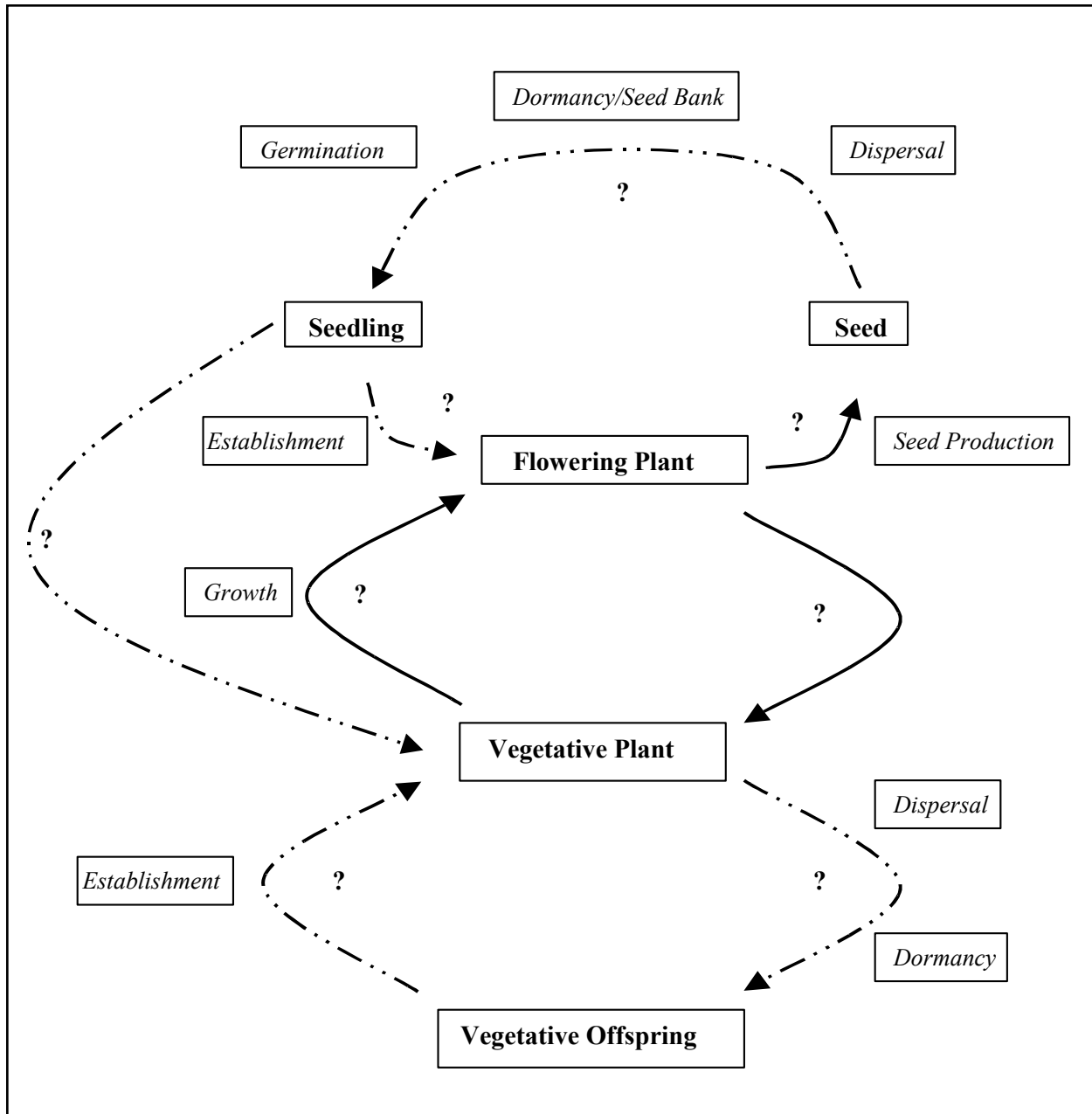


Figure 3. Schematic representation of the hypothesized life cycle of *Telesonix jamesii*. Dotted lines indicate juvenile phases of the life cycle and solid lines indicate mature phases of the life cycle. Extent of sexual and vegetative reproduction is unknown for this species. Rates of growth, dispersal, and seed production are also unknown (indicated by "?"). Figure adapted from Grime (1979).

species of *Boykinia* (*Telesonix*) are self-compatible to varying degrees. In arctic ecosystems, early-flowering species tend to be outcrossers, while late-flowering species tend to be self-compatible (Hansen and Molau 1994). Outcrossing could be unreliable when pollinators are not available, such as during short, cold summers. Species of *Saxifraga* show a wide range of strategies, from obligate outcrossing to self-compatibility to mixed systems (Hansen and Molau 1994).

Members of the family Saxifragaceae tend to have unspecialized insect-pollinated flowers and attract a variety of insects (Brochmann and Hapnes 2001). The tissues of *Telesonix jamesii* are covered with aromatic, glandular trichomes, and Gornall and Bohm (1985) hypothesized that the spicy aroma may serve to attract pollinators. Recorded insect visitors to *Saxifraga* and *Boykinia* flowers in arctic and alpine environments include members of the Coleoptera

(Staphylinidae), Diptera (Bibionidae, Calliphoridae, Empididae, Syrphidae, Otitidae, Muscidae), and Hymenoptera (Andrenidae, Apidae, Halictidae) (Gornall and Bohm 1985, Hansen and Molau 1994). Only some of these species are efficient and important pollinators, depending on the morphology, abundance, and phenology of the insects and plants (Hansen and Molau 1994). Stenstrom and Molau (1992) found that *S. oppositifolia*, an arctic species, is pollen limited, but it is unknown if *T. jamesii* is similarly limited.

Important issues related to the pollination of rare plants that have yet to be researched for *Telesonix jamesii* include the extent of self-pollination, the identity of effective pollinators, the role of plant density on pollination, the genetic implications of pollination, and the effect of environmental fluctuations on pollination. In addition, Hansen and Molau (1994) found that *Saxifraga granulata*, a boreal species, had different pollinators depending on the edaphic properties of the microhabitat, influence of neighboring habitats, relative abundance of conspecifics, and occurrence of sympatric species with similar cues.

Dispersal mechanisms

Preliminary research of seed dispersal mechanisms for *Telesonix jamesii* was conducted by Gornall and Bohm (1985). While most *Boykinia* seeds tend to have tubercles that can stick to feathers or fur of animal dispersers, the seeds of *B. jamesii* (*T. jamesii*) and *B. heucheriformis* (*T. heucheriformis*) are smooth (Gornall and Bohm 1985). Gornall and Bohm (1985) observed that the glandular trichomes found on the tissues of *Boykinia* and *Telesonix* species caused many of the small seeds to stick to the inflorescence, which may affect dispersal patterns and the genetic structure of populations. In other cases, seeds of these species got thrown or bounced out of the capsules when the flexible stems of taller plants waved in the wind or shorter plant stems vibrated in the wind (Gornall and Bohm 1985). Seeds could also be scattered if the flowering stems senesce, break off, and move downslope. The seeds of *T. jamesii* are small and appear to lack any adaptation that would facilitate wind or animal-mediated dispersal. *Saxifraga cotyledon* is a saxifrage found in rocky habitats of European alpine tundra environments, and presumably relies on wind, water, and gravity to move its seeds to favorable crevices (Dinnetz and Nilsson 2002). The dispersal success of *T. jamesii* most likely depends on wind and water patterns, topographic heterogeneity, and the availability of suitable “safe” sites.

Seed viability and germination requirements

No information is available concerning the fertility, seed viability, and germination requirements of *Telesonix jamesii* in the field. This species and its congener *T. heucheriformis* are heralded as being among the most beautiful Rocky Mountain alpine plants and are thus valued highly as horticultural species. Many western plant suppliers include “*Telesonix jamesii*” on their list of available species (e.g., Arrowhead Alpines 2003, Rocky Mountain Rare Plants 2003), but it is likely that these refer to *T. jamesii* sensu lato due to taxonomic confusion with this genus. Thus, plant material could be either *T. heucheriformis* or *T. jamesii*, depending on whether the stock was collected from Colorado. For example, Arrowhead Alpines (2003) offers plants based on collections from Teller County, CO, and thus these plants are more likely to be *T. jamesii* rather than *T. heucheriformis*.

Telesonix jamesii apparently grows well in shady rock gardens or in pots, and propagation of this species can be accomplished by planting seeds in the fall or dividing existing plants in the spring. *Telesonix jamesii* generally requires a shady spot in moist but well-drained soils (neutral to acidic), and it appears to grow best and flower when root-bound or in a tight crevice (Nicholls 2002, Arrowhead Alpines 2003). *Telesonix jamesii* sensu lato has also been cultivated at the Native Plant Nursery of Glacier National Park in Montana; extensive propagation protocols detail how to prepare vegetative cuttings, promote establishment and growth, and collect seeds (DeSanto et al. 2001). Seed propagation notes indicate that *T. jamesii* sensu lato seeds are generally non-dormant, seed longevity is unknown, and germination success is 25 percent for freshly sown seed. Light and gibberellic acid treatment enhance germination.

Phenotypic plasticity

Phenotypic plasticity is demonstrated when members of a species vary in height, leaf size, flowering time, or other attributes, with change in light intensity, latitude, elevation, or other site characteristics. Cronquist et al. (1997) observed specimens with flower characteristics intermediate between *Telesonix jamesii* and *T. heucheriformis* in central and western Wyoming. Also, Nicholls (2002) remarked that the *T. jamesii* flowers vary in color, and the specimens from Pikes Peak in Colorado have the deepest red color. It is unknown to what extent these phenotypic differences are caused by genetic or environmental influences.

Cryptic phases

No information regarding cryptic phases of *Telesonix jamesii* is available. The ability of established adult individuals to remain dormant during unsuitable conditions is unknown. Seed dormancy can be an important adaptation for alpine plant populations to exploit favorable conditions in a harsh or unpredictable environment (Kaye 1997). It is not known whether a persistent seed bank exists or what the extent of seed dormancy is for *T. jamesii*. *Saxifraga cotyledon*, another saxifrage species that grows on primary rock in European alpine environments, is not able to establish a persistent seed bank because soil and litter accumulations are largely absent in those habitats (Dinnetz and Nilsson 2002). However, Dinnetz and Nilsson (2002) did find viable seeds of at least one year old sticking to irregularities in the rock and in crevices with a tiny litter layer. Details of seed longevity, patterns of seed dormancy, and factors controlling seed germination for *T. jamesii* have not been studied.

Mycorrhizal relationships

The existence of mycorrhizal relationships with *Telesonix jamesii* was not reported in the literature.

Hybridization

Gornall and Bohm (1985) noted that experimental crosses between *Boykinia heucheriformis* (*Telesonix heucheriformis*) and *B. occidentalis* were successful; they used this evidence as rationale to include *Telesonix* species within the genus *Boykinia*. As discussed above, Cronquist et al. (1997) observed specimens with flower characteristics intermediate between *T. jamesii* and *T. heucheriformis* in central and western Wyoming; the researchers chose to recognize these two taxa as varieties within the genus *Telesonix*. It is not clear to what extent these two closely related taxa form hybrids or vary phenotypically. The authors of this assessment hypothesize that the ranges of these two taxa seem to be geographically separated by at least 200 miles, so it appears that hybridization in the field would be impossible without long-range pollen dispersal. Based on this hypothesis, it would be more likely that the two species vary phenotypically than that they form hybrids.

Demography

Little is currently known about population demographics in *Telesonix jamesii*. Research on other Saxifragaceae species, where available, may provide insights into some of the ecological, spatial, and genetic

considerations for *T. jamesii* demography. Refer to **Figure 4** and **Figure 5** for envirograms outlining resources and malentities potentially important to *T. jamesii*. An envirogram is a schematic diagram, first introduced by Andrewartha and Birch (1984) for animal species, that depicts relationships between a target organism and environmental conditions. The centra are the main categories (i.e., resources and malentities) that directly affect the target species, and the web outlines factors that indirectly influence the centra. The web depicts the most distal to most proximal factors using linear, one-way branches. Because there is a paucity of ecological information about this species, the envirograms outline hypothesized resources and malentities that are *potentially* important for *T. jamesii*. Additional information would be needed to create more comprehensive and specific envirograms.

Life history characteristics

There is no information regarding population parameters or demographic features of *Telesonix jamesii*, such as metapopulation dynamics, life span, age at maturity, recruitment, and survival. In an effort to elucidate potential demographic patterns for *T. jamesii*, we present information mainly from other rare, alpine, mat-forming species in the family Saxifragaceae.

Life cycle diagram and demographic matrix. A life cycle diagram is a series of nodes that represent the different life stages connected by various arrows that represent the vital rates (i.e., survival rate, fecundity). Demographic parameters, such as recruitment and survival rates, are not currently available for *Telesonix jamesii*, and so there are no definitive data regarding the vital rates that contribute to species fitness. Although stage-based models based on population matrices and transition probabilities can be used to assess population viability (Caswell 2001), adequate quantitative demographic data are needed for input into the model.

For *Telesonix jamesii*, the stages that could potentially be incorporated into a demographic matrix include seed, seedling, any rosette classes if appropriate, and reproductive (mature) individuals (**Figure 3**). Presumably, seeds of *T. jamesii* are dispersed to suitable locations. The probability of germination and subsequent establishment depends on the longevity of these propagules and whether appropriate environmental conditions exist for germination and growth. Seeds that germinate will grow into seedlings, assimilate resources, and mature into reproductive individuals. Cultivation notes suggest that this species grows new shoots and flowers every year (DeSanto et al. 2001).

WEB			CENTRUM: Resources
3	2	1	

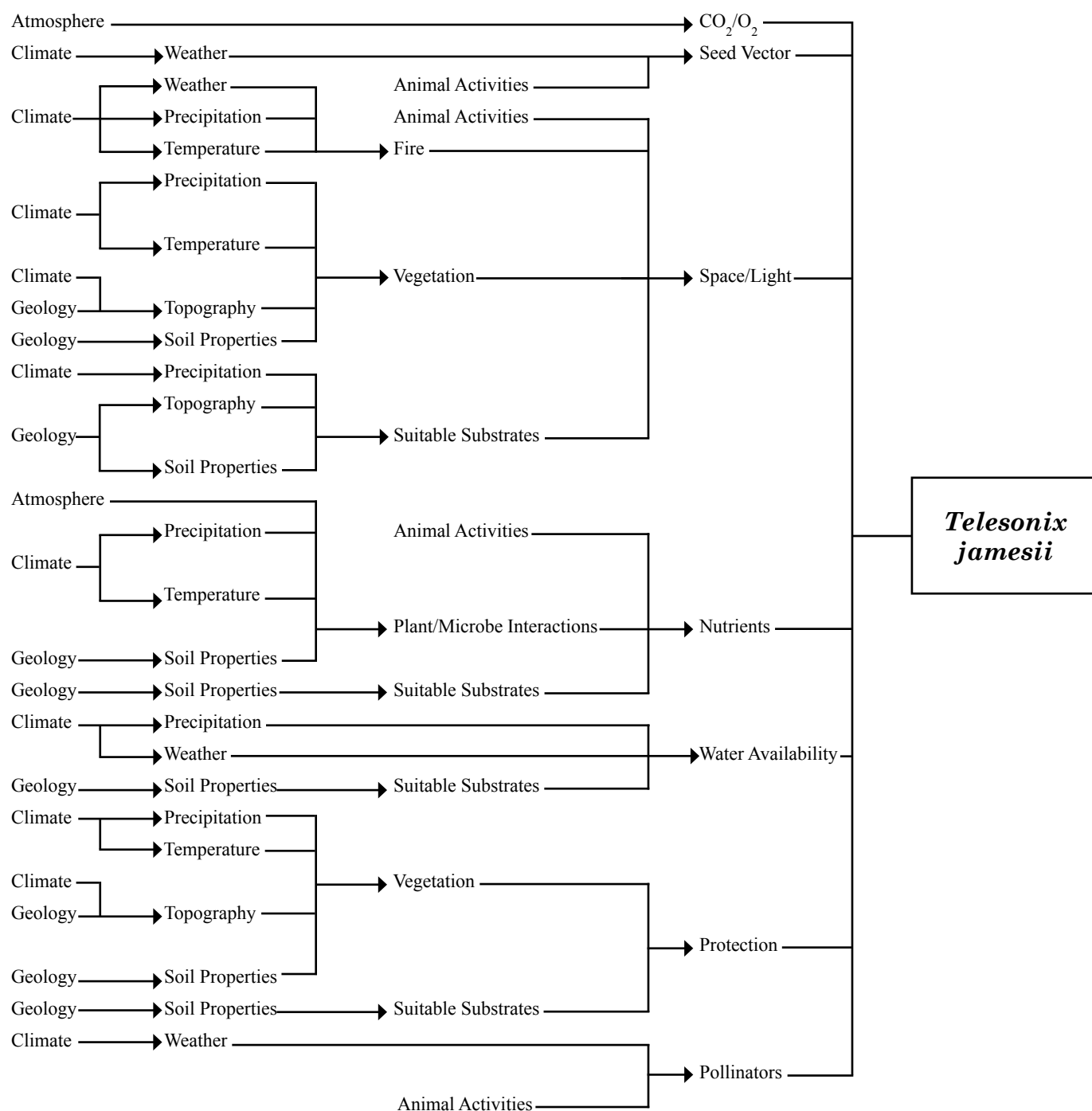


Figure 4. Envirogram outlining potential resources for *Telesonix jamesii*. An envirogram depicts direct and indirect factors that may influence a species. The centrum includes the most proximate factors and the web includes more distal factors.

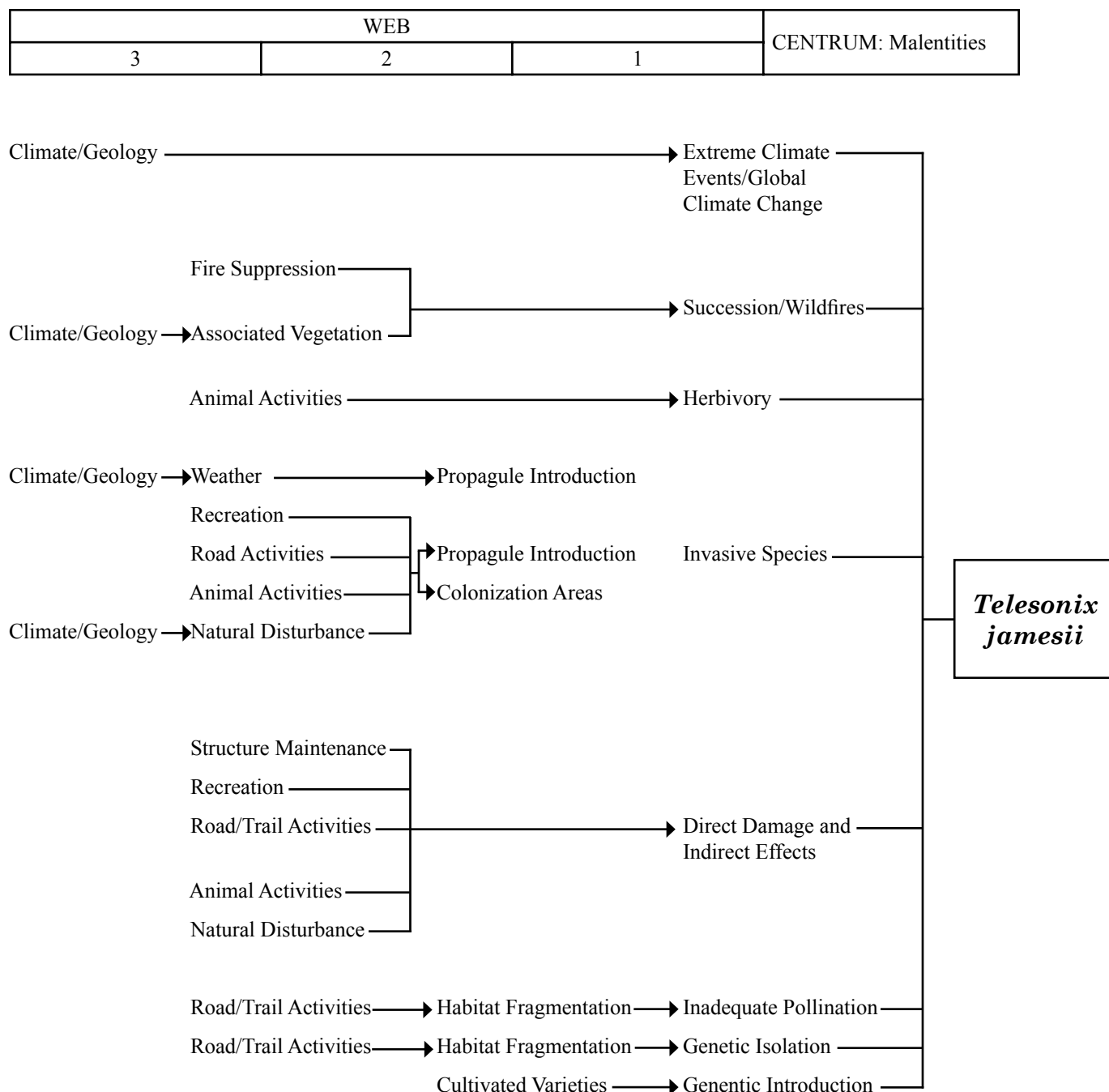


Figure 5. Envirogram outlining malentities to *Telesonix jamesii*. An envirogram depicts direct and indirect factors that may influence a species. The centrum includes the most proximate factors and the web includes more distal factors.

Growth rates may be influenced by the intensity and frequency of disturbance and the availability of resources, such as space, light, moisture, and nutrients. Successful seed set will depend on the rate of pollen and ovule formation, pollination, fertilization, and embryo development. Fecundity rates depend on the production of seeds and the percentage of those seeds that survive to germination in subsequent years. *Telesonix jamesii*'s

time to maturity and other demographic rates may be different under natural conditions compared to cultivated scenarios.

Population viability analysis. In order to initiate a population viability assessment for *Telesonix jamesii*, the rates of germination, fecundity, survival, and other important parameters require additional study. After a 5-

year study, researchers were able to construct a transition probability matrix and to perform a population viability analysis (PVA) for *Saxifraga cotyledon*, a long-lived perennial that grows on cliffs and rocks (Dinnetz and Nilsson 2002). They determined that this saxifrage is a perennial plant with semelparous, monocarpic rosettes that take at least four years to reach maturity. The PVA established that even small populations of this species are generally not in danger of extirpation, that the minimum viable population is at least 70 individuals, and that extinction risk is related to the interaction between environmental and demographic stochasticity.

Ecological influences on survival and reproduction

Germination, growth, seed production, and long-term persistence of *Telesonix jamesii* most likely depend on a range of ecological influences over many years, including climatic fluctuations, microsite conditions, herbivory levels, disturbance patterns, interspecific competition, and pollinator activities. There is little information on the capabilities of *T. jamesii* to disperse, colonize, and establish new populations around the landscape. One plant has established itself in an experimental garden on Pikes Peak, as a result of dispersing from adjacent tundra or sprouting as a “volunteer” from earlier plantings (Colorado Natural Heritage Program 2004). The establishment of new populations most likely depends on barriers to dispersal and the availability of suitable germination sites and conditions. The rate of population growth is also influenced by factors that affect sexual or vegetative reproduction, such as pollinator limitations. It is also unclear what type, size, intensity, or frequency of disturbance regime is important for *T. jamesii*. Disturbances in mountainous environments can include erosion, fire, blowdowns, frost heaving, wind-scouring, small mammal activity, environmental fluctuations, and human influences (Zwinger and Willard 1996). These disturbances could either create suitable habitat throughout a landscape or directly impact an existing population, depending on intensity and disturbance location. For example, *T. jamesii* growing on vertical cliffs may be protected from some erosive forces, populations on talus slopes could be extirpated by erosion or rockslide, and/or new suitable habitat could be created for future populations. Most populations of *T. jamesii* are unlikely to be directly affected by blowdowns or fire because they occur in rocky areas with scattered tree cover and minimal ground fuels. However, *T. jamesii* growing in montane habitats in coniferous forests could be more affected by the direct or indirect effects of fire. Large fires have burned in

the Front Range of Colorado, including the Black Mountain Fire (Staunton State Park) in 2002 (USDA Forest Service 2002) and the Buffalo Creek Fire (Pike-San Isabel National Forest) in 1996 (Martin 2000), but the effects of those fires on populations of *T. jamesii* are unknown. *Saxifraga bryophora* var. *tobiasiae* growing in rocky habitat in Idaho was largely unaffected by the direct effects of a wildfire or indirect post-fire erosion in the area. However, an intense fire in another area highly altered the soils, and researchers speculated that severe erosion inundated the saxifrage growing on small ledges and in runoff channels (Mancuso 2001). *Telesonix jamesii* could be similarly affected by the indirect effects of wildfire.

Spatial characteristics

The spatial distribution of *Telesonix jamesii* has not been studied. Characteristics that could influence the spatial distribution of this rare species may include habitat availability, seed dispersal patterns, competition with other vegetation, landscape and microsite heterogeneity, and disturbance patterns.

Telesonix jamesii populations appear to vary in size (e.g., from 100 to tens of thousands individuals) and spatial distribution (e.g., densely growing in just a small area or in cracks throughout a cirque) (Colorado Natural Heritage Program 2004). Metapopulations likely occur where *T. jamesii* occupies several suitable sites within a canyon or cirque, for example. The spatial configuration of metapopulations or the extent to which gene flow occurs between local and distant populations is unknown for this species.

Telesonix jamesii tends to grow on granitic soils in open plant communities with exposed rock surfaces (Colorado Natural Heritage Program 2004). Depending on topography and germination requirements, suitable habitat for seedlings could be rock crevices or small ledges, or patches of exposed ground. Seedlings of *Saxifraga mutata* were often found around the dead rosettes of adult individuals as a result of dispersal that occurred when winter snows bent the stems and capsules released the seeds (Holderegger 1996). Researchers found that the spread of *S. cotyledon* was not limited by suitable seedling establishment sites but rather by lack of available propagules and low rate of vegetative propagation. Similar studies have not been conducted for *T. jamesii*, and so the role of microtopography, suitable substrates, dispersal mechanisms, or number of propagules in the reproductive success of *T. jamesii* is unknown.

Disturbances (e.g., erosion, rockslide, fire, frost heaving, small mammal activity, human influences) likely play a large role in the distribution of *Telesonix jamesii* as well. As discussed in the section above, the types and effects of disturbances will differ depending on microhabitat. For example, rockslide, erosion, or sedimentation may be more important for *T. jamesii* growing on talus slopes or downslope from erodible surfaces (e.g., roads), and water scouring or rock movement may affect populations on cliff faces. Populations near hiking and pack trails could be affected by any trail-related damage, such as trampling or soil movement. Disturbances such as erosion on steep slopes most likely play a role in creating suitable habitat throughout the landscape as well as directly impacting existing populations. The type, size, frequency, and intensity of disturbances that define the natural disturbance regime and would affect colonization and extinction events are unknown. It is also unclear to what extent *T. jamesii* is capable of dispersing, colonizing, and establishing new populations around the landscape.

Genetic characteristics and concerns

To elucidate phylogenetic relationships of the Saxifragaceae, including *Telesonix jamesii*, Soltis et al. (1993, 1996, 2001) sequenced sections of saxifrage nuclear and chloroplast genomes. The researchers verified that significant genetic differences exist between the two *Telesonix* taxa to distinguish them as distinct species. The extent of hybridization between these species, as suggested by the discovery of intermediate specimens by Cronquist et al. (1997), has not been studied. Gornall and Bohm (1985) noted that experimental crosses between *Boykinia heucheriformis* (*T. heucheriformis*) and *B. occidentalis* were successful. Further taxonomic work may be warranted to elucidate the genetic characteristics related to intermediate specimens or successful hybrids.

Other genetic concerns, such as the amount of genetic variability between and within populations, have not been studied in detail for *Telesonix jamesii*. Issues related to gene flow, inbreeding, and genetic isolation could affect the demography, ecology, and management considerations for this species. In addition, the potential for propagated/cultivated individuals to influence the genetic characteristics of wild populations has not been assessed. Holderegger (1996) found that the persistence and size of small *S. mutata* populations were more affected by demographic than genetic processes. However, Lande and Shannon (1996) emphasize that

while genetic processes may not be important for persistence of a plant population over the short term, these processes are still critical for adaptation to a changing environment over the long term. Assessing the genetic variability of populations is also important for establishing conservation plans to protect genetic diversity and for designing reintroduction plans (Hollingsworth et al. 1998).

The base chromosome count for *Telesonix jamesii* is $2n=14$, characteristic of many species within the family Saxifragaceae (Soltis and Soltis 1980, Gornall and Bohm 1985).

Factors limiting population growth

Based on the information presented in the preceding sections, population growth or establishment of *Telesonix jamesii* could possibly be limited by competition with other species (e.g., invasive species), ineffective pollination, inadequate genetic variability for long-term persistence, or reduced habitat availability or quality as a result of human-related changes or environmental fluctuations. The rate at which colonization and establishment of new populations occurs is unknown. *Telesonix jamesii* individuals growing on cliff faces and in tight crevices rather than open habitats presumably experience different obstacles to seed dispersal, vegetative reproduction, and gene flow.

Community ecology

Herbivores and relationship to habitat

The extent and effects of herbivory on *Telesonix jamesii* are unknown. Where *T. jamesii* grows on cliff faces, this species is probably not susceptible to herbivory or soil disturbance by large mammals. Where plants occur in more accessible habitat, *T. jamesii* could be affected by grazing or disturbances by native herbivores (e.g., large ungulates, small mammals, insects) or livestock (e.g., sheep, cattle). None of the existing *T. jamesii* sites within the Pike-San Isabel National Forest are within active grazing allotments (S. Olson personal communication 2004). Craighead et al. (1963) and Gornall and Bohm (1985) reported evidence that *T. jamesii* and *T. heucheriformis* are eaten by elk and deer. Sheep grazing in *Saxifraga bryophora* var. *tobiasiae* habitats in Idaho did not appear to negatively affect this species (Mosely 1989). The palatability of *T. jamesii* to herbivores is unknown.

Competitors and relationship to habitat

The interactions of *Telesonix jamesii* within the plant community are not well known. This saxifrage is mostly found on rocky outcrops, cliff faces, and boulderfields in mountainous areas where the understory is sparsely vegetated and overstory coverage is minimal. It is unknown if *T. jamesii* is a poor competitor with other species. The relationship of *T. jamesii* to other associated chasmophytes, such as *Heuchera bracteata*, has not been studied. These co-occurring species could compete for available habitat or facilitate the accumulation of organic material and moisture. *Saxifraga cotyledon* populations tended to occupy openings in rocky habitats that were not colonized by mosses; it was completely absent from any areas with continuous vegetation (Dinnetz and Nilsson 2002). The characteristics of the natural fire regime and the response of *T. jamesii* to fire have not been studied. Fuel loads in alpine habitats are probably minimal and patchily distributed, resulting in spot fires with low temperatures that would not kill deep-rooted perennials. It is possible that fire may play a larger role for *T. jamesii* in lower elevation montane habitats. Johnston (2002) suggested that this species may possibly benefit from forest thinning, prescribed fires, or wildfires that reduce canopy cover.

There are no reports of exotic species specifically affecting *Telesonix jamesii*. Element occurrence records note that the perennial non-native plants such as *Phleum pretense* (timothy grass), *Carduus nutans* (musk thistle), and *Cirsium arvense* (Canada thistle) have been observed near populations of *T. jamesii* in montane habitats (Colorado Natural Heritage Program 2004). However, the records do not indicate which invasive species, the extent of the infestations, or the nearness of infestations to *T. jamesii* populations. The introduction of exotic species can be a secondary effect of trail and road construction, and in some instances, exotic species can outcompete native plants for space, nutrients, and water, eventually replacing the native species. Potential montane, subalpine, and alpine non-native invasive plant species in Colorado include Canada thistle, musk thistle, timothy grass, ox-eye daisy (*Chrysanthemum leucanthemum*), yellow toadflax (*Linaria vulgaris*), scentless chamomile (*Matricaria perforata*), dandelions (*Taraxacum officinale*), and white clover (*Trifolium repens*) (Chumley 1998). Fayette and Grunau (1998) recorded the presence of yellow toadflax (*Linaria vulgaris*) on the Pikes Peak tollway and along the cog railroad but noted that it had not yet moved into the natural vegetation. In 2003, S. Tapia (personal communication 2003) reported that yellow toadflax in

subalpine areas had spread significantly from roadside areas and was encroaching populations of other rare native plant species. The spatial juxtaposition (i.e., nearness) of these invasions to existing populations of *T. jamesii* is not known. The threat of exotic species to *T. jamesii* most likely depends on geographic location, elevation, the distance from weed hotspots (e.g., roads and trails), dispersal mechanisms, and other factors related to disturbance factors.

Parasites and disease

Reports indicate that there is no evidence of parasites or diseases on *Telesonix jamesii* (Colorado Natural Heritage Program 2004). Gornall and Bohm (1980) identified unglycosylated polymethylated flavonols and flavones in Saxifragaceae species (including *T. jamesii*) and hypothesized that these compounds play a role in the protection of plants against chronic diseases. The only studied species that lacked the polymethylated flavonoid aglycones was prone to infestation by red-spider mites in the growth chamber. Species of the *Boykinia* group tend not to be infected by microcyclic rusts (e.g., *Puccinia* spp.) that commonly parasitize other Saxifragaceae species, although one *Boykinia* specimen in an herbarium was found to be infected with *Puccinia heucherae* (Soltis and Soltis 1980, Gornall and Bohm 1985).

Symbiotic interactions

Insect pollination of flowering plants is an example of an important symbiotic interaction. Plants lure insects to a pollen or nectar reward, and the insects carry pollen to other flowers, thus, helping to cross-fertilize. Specific details concerning pollination ecology of *Telesonix jamesii* are largely unknown. The positive interactions between associated plant species and *T. jamesii* and the role of any mycorrhizal associations are unknown.

Habitat influences

Telesonix jamesii appears to be a habitat specialist on exposed granitic substrates at a wide range of montane to alpine elevations. Within these habitats, *T. jamesii* inhabits a variety of microhabitats, ranging from rocky outcrops to boulderfields to cliff faces, with different slopes and aspects (Colorado Natural Heritage Program 2004). The availability and quality of suitable habitat most likely vary from area to area, depending on heterogeneity in topography, environmental fluctuations, disturbance factors, and competition with other species.

CONSERVATION

Threats

Threats to the long-term persistence of *Telesonix jamesii* in USFS Region 2 are largely inferred because of our lack of understanding of and research on this species. The information presented in this section is primarily based on observations in occurrence records (Colorado Natural Heritage Program 2004) and personal communications with resource management specialists and botanists (D. Anderson personal communication 2004, J. Connor personal communication 2004, J. Hovermale personal communication 2004, S. Olson personal communication 2004). These factors are summarized in an envirogram outlining malentities potentially important to *T. jamesii* (centrum) and the indirect variables affecting those centrum factors (**Figure 5**).

Of the 21 occurrences of *Telesonix jamesii* worldwide, approximately 12 occurrences are entirely or partly on USFS lands in Colorado. Most of these occurrences are in areas managed for multiple uses, and one population may be in a wilderness area (**Table 1**). The remaining nine populations of *T. jamesii* occur on federal lands, state lands, or private lands. As discussed earlier, populations of species of concern on USFS and NPS lands obtain some protection from collection and from the impacts of federal projects. Management or protection of populations of *T. jamesii* on state or private lands is not known.

Populations of *Telesonix jamesii* could potentially be threatened by a variety of human-related activities (e.g., road-related impacts, recreation), or ecological changes (e.g., global climate changes, invasive species introduction). The specific threats will likely vary from population to population, depending on the landscape context. Estimating the numbers of populations potentially threatened by certain activities (e.g., road activity) is associated with considerable uncertainty because descriptions of the populations and their landscape context are sparse. For example, a population may be “near a road” and could subsequently suffer intense impacts from direct trampling, road dust, associated erosion and deposition. Alternatively, it could suffer minimal effects if the road is not heavily traveled or if the population is some distance from the road. In addition, human-related activities and other disturbances can either create suitable habitat throughout a landscape or directly impact an existing population, depending on frequency, intensity, size, and location. Direct impacts could either damage the existing individuals or reduce

reproductive success, available habitat, establishment of new populations, or other factors important for long-term persistence of the species.

Telesonix jamesii occurrences are primarily located near urban population centers along the Front Range of Colorado, and thus USFS and state lands in this area are or will be heavily used by recreationalists (D. Anderson personal communication 2004, J. Hovermale personal communication 2004, S. Olson personal communication 2004). Direct or indirect negative impacts to *T. jamesii* populations or habitat by human-related activities could occur from motorized and non-motorized recreation, trail or road construction and maintenance, changes to natural disturbance regimes, invasive species introduction, structure construction and maintenance, horticultural collection, or crystal collecting (Colorado Natural Heritage Program 2004). Those populations closest to roads, trails, rock-climbing areas, or other human-related structures (e.g., radio towers, reservoirs) are likely at the most risk.

Disturbances associated with roads (e.g., trampling, erosion/sedimentation, introduction of non-native seeds, horticultural collection) may be the largest threat to *Telesonix jamesii*. Five of the 12 occurrences of *T. jamesii* entirely or partly on the Pike-San Isabel National Forest are potentially near trails, roads, or railroads (Colorado Natural Heritage Program 2004). Roads can be associated with significant erosion and sedimentation and could possibly affect populations of *T. jamesii* found downslope from roads. For example, the Pikes Peak toll road is creating substantial and significant erosion and sedimentation issues for the surrounding landscape that could affect populations of *T. jamesii* (Colorado Natural Heritage Program 2004). Paving of the Pikes Peak road will continue over the next several years (J. Hovermale personal communication 2004). The paving and use of sedimentation control structures will presumably reduce the risk of erosion/deposition to *T. jamesii* in the future, but current construction processes could potentially impact individuals of this plant near the existing road. One of the authors of this assessment noted that the coarser, denser rock material used as railroad ballast for the Pikes Peak Cog Railroad does not appear to cause the same sedimentation problems as the toll road because it is not as erodible. Roads and trails are also often associated with the spread of invasive plants that could compete with *T. jamesii* for resources.

Motorized vehicles and foot traffic near roadsides, road pullouts, and trailheads have the potential to cause trampling of *Telesonix jamesii* populations occurring

near those areas. One of the authors of this assessment noted that trampling by people was clearly occurring at the Windy Point area on Pikes Peak, potentially near *T. jamesii* individuals, especially because trails are not delineated and it is not clear where it is acceptable to walk or not walk. In general, surface disturbances in alpine habitats can take much longer to restore (Zwinger and Willard 1996). One element occurrence noted that no apparent damage was occurring to the *T. jamesii* individuals found nearby a popular trail (Colorado Natural Heritage Program 2004). Off-highway vehicle use in the areas with *T. jamesii* occurrences on the Pike-San Isabel National Forest is generally restricted to existing roads and is prohibited in wilderness areas (S. Olson personal communication 2004). Several occurrences of *T. jamesii* occur on the southern flank of Pikes Peak in areas where private land (i.e., reservoirs owned by Colorado Springs Utilities) is interspersed with USFS land. Thus, any occurrences of *T. jamesii* on these private land parcels could be affected by any additional structure construction, reservoir expansion, or road maintenance activities. Public activity is excluded from the private land areas around the reservoirs, which reduces the number of visitors to the area (J. Hovermale personal communication 2004). There are also some radio towers located on USFS land near *T. jamesii* occurrences, and there are numerous two-track roads running through the USFS habitat in that area (Colorado Natural Heritage Program 2004). Both motorized vehicles and hikers have the potential to directly trample *T. jamesii* populations found in these more accessible habitats.

Recreational activities (e.g., hiking, camping, wildlife watching, sight-seeing, rock climbing, crystal collecting) are popular in areas of the Pike-San Isabel National Forest and Rocky Mountain National Park with *Telesonix jamesii* populations. Although *T. jamesii* populations on cliff faces and in boulderfields are less likely to be affected by road-specific activities, these less accessible populations could still be affected by off-road and off-trail recreational activities (J. Connor personal communication 2003, D. Anderson personal communication 2004). Because flowers of this species are so showy, populations of *T. jamesii*, especially near roads and trails, could be susceptible to horticultural collection. Johnston (2002) noted that this species is commonly advertised for sale and that it is unknown how often humans are collecting the plants or its seeds. Overutilization of *T. jamesii* for educational or scientific purposes is unknown, but any increased demand for this species could be a future threat. Rock climbing is a popular activity in both the Pikes Peak area and the Twin Owls area of Rocky Mountain National Park,

and rock climbing could negatively impact *T. jamesii* plants along climbing access trails, at the base of cliffs, and in cracks along climbing routes. The juxtaposition of climbing routes and *T. jamesii* populations is not known. Similarly, people interested in crystal collecting, or “rockhounding”, could also trample plants. Several sub-occurrences of *T. jamesii* occur in Staunton State Park, which is expected to be open to recreationalists in 2006 (Stein 2004). Threats to this species from trail use, rock climbing, crystal collecting, and exotic weed invasion are expected to sharply increase when the park is opened (Colorado Natural Heritage Program 2004), and a management plan is being created to map out potential trail routes and rock climbing areas (D. Anderson personal communication 2004, Stein 2004).

The effects of land management activities or environmental fluctuations on *Telesonix jamesii* have not been studied. In general, land management activities or other environmental disturbances (e.g., succession, fire, drought, rockfall, flash flood, global warming, erosion, or blowdown) can either create suitable habitat throughout a landscape or directly impact an existing population, depending on the frequency, intensity, size, and location of the disturbance. For example, a low-intensity fire may positively affect *T. jamesii* individuals by removing shade cover (Johnston 2002), whereas a high-intensity fire may cause increased surface water runoff and increased soil erosion and deposition that could negatively impact *T. jamesii* individuals. Populations of *T. jamesii* that occur on high elevation ridges, cliff faces, steep slopes, or other areas with exposed bedrock and low productivity may be less affected by wildfires, blowdowns, prescribed burning or thinning, and associated road-building activities than more accessible populations below treeline. The authors of this assessment note that historical timbering and mining (e.g., gravel pits, gold mining) have occurred in habitats with *T. jamesii*, but the current extent of those activities is unknown. Forest lands in Staunton State Park are targeted for significant thinning activities in order to minimize threat from future wildfires (Martinez 2003, Stein 2004).

Other environmental or biological threats to populations or habitats of *Telesonix jamesii* could include non-native species introductions, excessive herbivory, inadequate pollination, genetic isolation, hybridization, or global climate change. The possibility for hybridization or other genetic interaction with cultivated varieties of this species is unknown. *Telesonix jamesii* is valued highly as horticultural species and is sold by a variety of plant suppliers (e.g., Arrowhead Alpines 2003, Rocky Mountain Rare Plants 2003).

The effects of native herbivores, such as small mammals, ungulates, or insects, on *T. jamesii* are unknown. Individuals of *T. jamesii* in sparsely-vegetated and/or steep cliff habitat might experience less herbivory from large mammals. The areas with *T. jamesii* occurrences in the Pike-San Isabel National Forest are not currently active grazing allotments (S. Olson personal communication 2004).

Changes to existing climatic and precipitation patterns, perhaps as a result of global climate change, could also impact *Telesonix jamesii*. For example, average temperatures are projected to increase and precipitation is generally expected to increase over western North America (U.S. Environmental Protection Agency 1997, Watson et al. 2001). A document about regional climate changes in Colorado by the Environmental Protection Agency reports that average temperatures have increased by 4.1 °F and precipitation has decreased by up to 20 percent in some areas of Colorado over the last century (U.S. Environmental Protection Agency 1997). Over the next century, climate models predict that temperatures in Colorado could increase by 3 to 4 °F (with a range of 1 to 8 °F) in the spring and fall and by 5 to 6 °F (with a range of 2 to 12 °F) in the summer and winter. Precipitation is estimated to increase by 10 percent in spring and fall, increase by 20 to 70 percent in the winter, and create more thunderstorms in the summer (without a significant change in precipitation total) (U.S. Environmental Protection Agency 1997). Climate change and other potential changes to a suite of environmental variables could affect plant community composition by altering establishment, growth, reproduction, and death of plants. For example, model projections predict that tree lines could shift upslope in alpine ecosystems (U.S. Environmental Protection Agency 1997). In addition, environmental stochasticity can also affect pollinator activity and behavior.

Conservation Status of the Species in USFS Region 2

Telesonix jamesii is a species of special concern because it is a geographically limited plant with potential threats to existing populations and habitat. The viability of this species within USFS Region 2 is difficult to ascertain because the full range and abundance within the region is unknown and demographic parameters have not been studied. A majority of *T. jamesii* occurrences are located entirely or partly on USFS lands (**Table 1**). As a result, the conservation of populations on National Forest System lands appears to be especially important to the global conservation

status of this species. Road and structure construction, motorized and non-motorized recreation, exotic species invasion, horticultural collection, environmental fluctuations, and changes to natural disturbance patterns potentially threaten this species. Much information is lacking on its abundance, distribution, and biology. It is difficult to predict the ability of this species to tolerate environmental stochasticity and any future environmental or management changes. The vulnerability of this species on USFS lands is high, and the long-term viability of this species is unknown.

Population declines

Based on the existing estimates of abundance, we are unable to conclude that the distribution or abundance of *Telesonix jamesii* is declining, expanding, or remaining the same throughout its range. Abundance estimates for the Colorado populations ranged from “plentiful” to tens of thousands per site (Colorado Natural Heritage Program 2004). “It appears to be common within its restricted range of habitats, with large to very large populations.” (Johnston 2002). Johnston (2002) has made some repeated observations of a few populations and has not seen signs of decline. There have been no detailed status reports or intensive surveys for this species, and abundance estimates are difficult to obtain because of clumped individuals and inaccessible populations (Colorado Natural Heritage Program 2004). It is probable that population sizes have been underestimated (Johnston 2002, Colorado Natural Heritage Program 2004). Johnston (2002) estimates that there may be as many as 50 populations and perhaps up to 100,000 individuals. Although seven occurrences on USFS lands have been estimated by observers to have good to excellent viability, the other five occurrences do not have recent recorded observations and the viability of those populations is unknown.

Habitat variation and risk

Although *Telesonix jamesii* appears to be edaphically restricted to exposed granitic substrates, this species inhabits a wide range of elevations and microhabitats, such as boulderfields, cliff faces, and rocky outcrops. Inhabiting different habitats over a range of elevations and within different landscape contexts may insulate *T. jamesii* from complete extirpation by one particular factor, such as structure construction or trampling. The inaccessibility of many *T. jamesii* occurrences in steep, rocky, alpine terrain also serves to protect populations from some human and livestock grazing impacts. In contrast, this plant is generally restricted to a small geographic area in

Colorado (and possibly Wyoming and New Mexico), and the reasons for the endemism and scattered occurrences, despite seemingly plentiful habitat, are not known. The microhabitat requirements for *T. jamesii* are largely undefined. Potential risks within the habitats could include competition from surrounding vegetation, lack of suitable germination sites, inadequate pollinator habitat, barriers to gene flow, unsuitable conditions for adequate growth and development, or other fluctuations in disturbance processes that could affect existing populations or creation of habitat. The optimal type, size, frequency, and intensity of disturbances required to sustain populations of *T. jamesii* are not known. Natural disturbances (e.g., erosion) likely play a beneficial role to create suitable habitat for *T. jamesii* but could also be detrimental to existing individuals depending on location and intensity. It is difficult to predict the spread of non-native invasive plants and potential risk of alteration to plant communities. Specific populations could be at a greater risk than other populations, depending on the landscape context and characteristics of the natural and human disturbance regimes. Johnston (2002) suggests that *T. jamesii* environments are probably highly resilient but no one has monitored the habitat.

Element occurrence records suggest that additional populations of this species may exist in inaccessible areas and parts of the range that have not been intensively surveyed. For example, populations of this species may exist in suitable habitat in the Arapaho-Roosevelt National Forest (Johnston 2002). The unverified record of *Telesonix jamesii* in New Mexico may occur on private land (B. Sivinski personal communication 2003). Populations of *T. jamesii* on private land are probably not surveyed or protected.

Potential Management of the Species in USFS Region 2

Quantitative demographic monitoring and detailed biological and ecological studies of *Telesonix jamesii* populations and its habitat have not occurred. Based on the available information, we can only hypothesize how changes in the environment may affect the abundance, distribution, and long-term persistence of this species.

Management implications

Specific *Telesonix jamesii* populations and habitat may be at risk as a result of management activities within the range. As discussed previously, possible human-related threats to existing populations of this species include off-road (or off-trail) motorized and non-motorized activities, road maintenance and

sedimentation, structure construction, introduction of non-native species, and horticultural collection. These threats apply to most *T. jamesii* occurrences, including those on USFS Region 2 lands. For example, occurrences of this species near the Pikes Peak toll road on USFS lands could be affected by sedimentation, paving activities, trampling from recreationalists, competition with non-native species, and horticultural collection.

The long-term persistence of *Telesonix jamesii* will rely on monitoring the effects of current management practices and reducing human-related threats to existing populations. Currently, the response or exposure of *T. jamesii* to prescribed fires, thinning, timber harvest, or road paving activities is unknown. There are no management actions specifically protecting populations of this species. Some examples of management practices that would protect *T. jamesii* habitat and minimize possible plant destruction include protecting roadside populations during road paving activities, adequately marking trails near existing populations, encouraging hikers to stay on trails, educating rock climbers about species of concern, and preventing the spread and establishment of non-native invasive species. The opening of Staunton State Park may increase threats to *T. jamesii*, and regulating recreational activities may pre-empt damage to existing populations. Habitat management could also consider issues related to the surrounding landscape, such as barriers to dispersal and landscape fragmentation.

Potential conservation elements

Telesonix jamesii is a regional endemic with a small number of recorded populations (fewer than 20 known occurrences) and potentially high vulnerability to human-related activities and environmental changes. The microhabitat needs of this species and intensity, frequency, size, and type of disturbance optimal for persistence of this species are unknown. The lack of information regarding the colonizing ability, adaptability to changing environmental conditions, sexual and vegetative reproductive potential, or genetic variability of this species makes it difficult to predict its long-term vulnerability.

Priority conservation tools for this species may include reducing any imminent human-related threats to existing high-risk populations, documenting and monitoring the effects of current land-use practices and management activities, assessing the possible impact of human recreational and collection activities, assessing population trends, and verifying taxonomic

relationships. Additional key conservation tools may include verifying historical populations and possible occurrences in Wyoming and New Mexico, surveying high probability habitat for new populations, preventing non-native plant invasions, studying demographic parameters and reproductive ecology, and assessing the effects of future management activities or changes in management direction.

Features of *Telesonix jamesii* biology that may be important to consider when addressing conservation of this species (i.e., key conservation elements) include its preference for granitic substrates and rock crevices, elevational range of habitats, cliff face habitat and possibly underestimated population sizes, relatively large populations in small geographic areas, possible susceptibility to human-related activities, discontinuous distribution, showy flowers and attractiveness to horticultural collectors, and apparent ease in *ex situ* propagation and implications for natural reproduction.

Telesonix jamesii occurs at a range of elevations from montane to alpine environments. Within these habitats, *T. jamesii* inhabits a variety of microhabitats, ranging from rocky outcrops to boulderfields to cliff faces, with different slopes and aspects. In addition, this species appears to prefer granitic substrates, such as Pikes Peak granite, but the extent of edaphic specialization is not known. It is unknown how much suitable habitat for this species exists or what the range of ecological tolerances may be for this species. Inhabiting different habitats (e.g., montane to subalpine) over a range of elevations and within different landscape contexts (e.g., wilderness area, motorized recreation areas) may insulate *T. jamesii* from complete extirpation by one particular factor. The spatial extent and abundance of this species may be underestimated as a result of the inaccessible nature of cliff face habitats. Based on known populations, this species appears to be distributed in geographically isolated locations (e.g., Pikes Peak area, Staunton State Park area, Rocky Mountain National Park), and it is unlikely that there is exchange of genetic material from one area to another. The spatial extent of genetic exchange between populations is unknown for this species, and it is possible that there are undiscovered populations in unsurveyed areas. Although *T. jamesii* has relatively large populations (e.g., hundreds to tens of thousands of individuals), these occurrences are currently found in small geographic areas (e.g., Pikes Peak area) with extensive human activities. Thus, the effect of these activities on *T. jamesii* could have important implications for the conservation of this species. This species has showy flowers and is potentially attractive

for horticultural collection, which may threaten existing individuals, add to knowledge about the species, and/or serve as a potential resource for any restoration efforts. The fact that *T. jamesii* appears to be easily propagated and was observed as a plant in an experimental garden on Pikes Peak (Colorado Natural Heritage Program 2004) could suggest that this species would have high survivability in the field.

Tools and practices

There are no existing population monitoring protocols for *Telesonix jamesii*, and very little is known about the biology, ecology, and spatial distribution of this saxifrage. Thus, quantitative species monitoring, additional habitat surveys, and ecological studies are priorities for constructing a current status assessment and conservation plan.

Species inventory and habitat surveys

Current reports of existing *Telesonix jamesii* populations provide a useful base of information, but the distribution and total abundance of this species is not sufficiently known to formulate regional conservation strategies. For example, population abundance may be underestimated in some cases, and the current abundance of historical locations is not known. Locations of *T. jamesii* populations reported for southern Wyoming and northern New Mexico need to be revisited to determine if the species occurs at those locations, and if it does, specimens should be collected. Ascertaining the current abundance of this species would help to estimate the vulnerability of this species to any future changes in management or environmental fluctuations. Revisiting populations would also help to determine if individuals are imminently threatened by human-related activities.

Additional surveys of high probability habitat are needed to discover any additional populations and to document the full spatial extent of this species. The distribution of *Telesonix jamesii* is scattered within a fairly small region, with metapopulations spread over a range of elevations in a variety of microhabitat types. New surveys could use reports of existing populations as a starting point because similar habitats may extend along similar topographic lines. Researchers could also identify areas of potential habitat in a particular habitat type using topographic maps, geologic maps, and aerial or satellite images. Identifying possible indicator species (e.g., *Heuchera* spp.) or substrates (e.g., Pikes Peak granite) will also aid surveyors. Inventorying and surveying for this species in some areas may require

a field crew experienced in rock climbing techniques. Failure to find *T. jamesii* in potential habitat would also advance knowledge about this species, such as knowledge of the extent of edaphic specialization.

Once located, the size and extent of *Telesonix jamesii* populations could be mapped and recorded using global positioning system (GPS) and geographic information systems (GIS) technology. The spatial extent of populations in inaccessible areas may only be estimated. Mapping the extent of each known population of *T. jamesii* will maintain consistency for future observations, facilitate information sharing, and help in making estimates of density and abundance. Mapping exercises will also elucidate the spatial distribution of populations at the local and regional levels. Also, populations in areas slated for various management, maintenance, or disturbance activities could be readily identified.

Population monitoring and demographic studies

Additional information is needed to gain an understanding of the life cycle, demography, and population trends of *Telesonix jamesii*. Information is lacking on longevity, germination requirements, seed survival, extent of asexual reproduction, factors affecting flower development, pollination ecology, role of a seed bank, and gene flow between populations. This type of species-specific information would be useful in assessing threats to this species and in estimating species viability. For example, studies of germination needs in the field might elucidate potential limiting factors for the establishment of new individuals.

No data are available on population trends for this species, and no long-term demographic monitoring has been initiated. Long-term monitoring studies could yield helpful information, such as temporal and spatial patterns of abundance and dormancy; environmental factors that influence abundance; whether populations are increasing, decreasing, or remaining stable; and the minimum number of plants necessary to perpetuate the species. In addition, further studies on the genetic differences between and among populations will clarify metapopulation dynamics and extent of phenotypic plasticity. Additional genetic studies, especially on individuals that are intermediate between *Telesonix jamesii* and *T. heucheriformis*, may help to fully understand the relationship between these two species.

Understanding certain aspects of demography is a priority in order to provide basic population information:

- ❖ What are the rates of survival, longevity, and recruitment?
- ❖ What are the population fluctuations from year to year?
- ❖ What are the effects of disturbances on demographics?
- ❖ What are the role, status, and longevity of the seed bank?
- ❖ What is the age structure of the population?
- ❖ What is the age at which individuals become reproductive?
- ❖ What is the extent of vegetative and sexual reproduction?
- ❖ What is the gene flow between populations?

Several groups have developed protocols for monitoring population and demographic trends of rare plant species. These protocols can be easily accessed and used to develop specific monitoring plans for use in USFS Region 2. For example, *Measuring and Monitoring Plant Populations* (Elzinga et al. 1998) and *Monitoring for Conservation and Ecology* (Hutchings 1994) are general references that provide concrete guidance on designing and implementing quantitative monitoring plans for rare plant species. *USDA Forest Service Region 2 TES Plant Management Strategy* (Austin et al. 1999) and *Protocols and Models for Inventory, Monitoring, and Management of Threatened and Endangered Plants* (Bonham et al. 2001) provide helpful protocols specifically designed for federal agencies monitoring plants on public lands. Mancuso (2001) used permanent belt transects to monitor *Saxifraga bryophora* var. *tobiasiae* in Idaho to gauge population density, changes in age classes over time, and effects of wildfires. In addition, population matrix models that measure individual fitness and population growth provide flexible and powerful metrics for evaluating habitat quality and identifying the most critical feature of the species' life history (Hayward and McDonald 1997). Deterministic demographic models of single populations are the simplest analyses

and are used as powerful tools in making decisions for managing threatened and endangered species (Beissinger and Westphal 1998).

Habitat monitoring and management

The general habitats of *Telesonix jamesii* have been identified, but there are many unknowns regarding microhabitat requirements and basic population dynamics to determine which factors are critical in maintaining or restoring habitat for these species. For example, it is currently not known what types, intensities, or frequencies of disturbance create and maintain habitat and are tolerated by existing populations of this species. Land management techniques, such as timber harvest, thinning, prescribed burns, and fire suppression, may be used in some of *T. jamesii*'s habitats and could influence the persistence of this species. The cumulative beneficial or detrimental effects of these activities on *T. jamesii* and its habitats have not been studied or monitored. Documenting land management and monitoring habitat could occur in conjunction with population monitoring efforts in order to associate population trends with environmental conditions.

Some examples of management practices that would protect *Telesonix jamesii* habitat include restricting off-road vehicle traffic, reducing sedimentation from roads, encouraging hikers to use trails, educating rock climbers about species of concern, preventing any unauthorized horticultural collection of rare plants, and preventing the spread and establishment of non-native invasive species. Habitat management could also consider issues related to the surrounding landscape, such as pollinator habitat needs, herbivore movement patterns, and trail proximity and position in relation to population locations.

Biological and ecological studies

Much of the information regarding habitat requirements, establishment, reproduction, dispersal, relationship with herbivores, competition with other species, and overall persistence has not been studied for *Telesonix jamesii*. The response of *T. jamesii* to habitat changes is not known in sufficient detail to evaluate the effects of changes in disturbance patterns. Research studies to evaluate the effects of erosion, succession, and fire at several scales (local and regional) would provide valuable input to the development of conservation strategies and management programs. The types of monitoring studies required to understand how this species responds to environmental fluctuations, changes

in the disturbance regime, or natural succession could be complex and take several years. For example, it will be difficult to determine to what extent disturbances are necessary to create habitat and/or to maintain a population, what disturbance intensity and frequency may be most appropriate, and what factors would result in local extinction of a population. However, less complex studies, such as monitoring this species before and after land management projects (e.g., prescribed burn) or monitoring this species in popular rock-climbing areas, would significantly advance our knowledge of this species.

There is a body of research on the biology and conservation of other species of Saxifragaceae from arctic and alpine environments that would provide useful for designing future studies of *Telesonix jamesii* (e.g., Wehrmeister and Bonde 1978; Gerdol 1992; Stenstrom and Molau 1992; Hansen and Molau 1994; Nilsson 1995a and 1995b; Holderegger 1998; Sandvik et al. 1999; Lutz et al. 2000; Sandvik and Totland 2000; Dinnetz and Nilsson 2002).

Availability of reliable restoration methods

As discussed above, *Telesonix jamesii* has been successfully propagated in greenhouse/garden environments, and this introduces the possibility of restoration efforts if necessary. Germination and transplantation studies in natural environments would be helpful if populations are at risk of extirpation.

Information Needs and Research Priorities

Identifying high-quality populations and immediately threatened populations, revisiting and mapping the extent of reported populations, monitoring population trends and documenting land management, investigating factors affecting spatial distribution (e.g., microhabitat characteristics), studying the relationship between *Telesonix jamesii* and *T. heucheriformis*, producing information related to demography, and exploring biological and ecological limitations are of primary importance to further the understanding of *T. jamesii* in USFS Region 2.

Based on our current understanding of *Telesonix jamesii*, we can identify research priorities where additional information will help to develop management objectives, initiate monitoring and research programs, and inform a conservation plan. To address these data gaps, information can be obtained through surveys, long-term monitoring plans, and extended research

programs. There is so little known about the biology and ecology of this species that there are a large number of research projects that could be implemented. The following types of studies are priorities to supplement our basic knowledge regarding this species:

- ❖ Revisiting and detailed mapping of reported populations
- ❖ Verifying Wyoming and New Mexico occurrences
- ❖ Documenting and monitoring current land uses and management practices
- ❖ Addressing any imminent threats to existing populations
- ❖ Studying the relationship between *Telesonix jamesii* and *T. heucheriformis*
- ❖ Surveying for new populations
- ❖ Characterizing and measuring microhabitat features
- ❖ Investigating reproductive biology, including pollinator surveys, germination trials, vegetative reproduction, dispersal capabilities, mycorrhizal associations, and seedbank analyses

- ❖ Conducting genetic analyses to assess gene flow and variability throughout range

Additional research and data that may be useful but are not incorporated into this assessment include aspects related to managing data for efficient use. Data acquired during surveys, inventories, monitoring programs, and research projects are most easily accessible if they are entered into an automated relational database. The Colorado NHP and NatureServe have developed databases and GIS components to assist in information storage and habitat modeling (D. Anderson personal communication 2004). Such a database should be integrated with GIS and allow queries and activities such as the following:

- ❖ Efficient incorporation of data in the field
- ❖ Generation of location and habitat maps
- ❖ Identification of population locations
- ❖ Characterization of associated habitat types
- ❖ Identification of population trends over time
- ❖ Identification of data gaps that require further information gathering
- ❖ Simple modification of the database as additional information becomes available.

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DEFINITIONS

Annual – A plant that completes its entire life cycle in one growing season.

Anther – Part of the flower reproductive structure (stamen) that bears pollen.

Asexual reproduction – Any form of reproduction not involving the union of gametes.

Bract – Reduced, modified leaf associated with flowers.

Calyx – The collective name for sepals.

Campanulate – Bell-shaped.

Cauline – On or pertaining to a stem.

Chasmophytic – Growing in crevices.

Congener – A member of the same genus.

Connate – Grown together or mutually attached.

Cordate – Shaped like a heart.

Corolla – Portion of flower comprised of petals.

Crenate – With rounded teeth along the margin.

Cuneate – Wedge-shaped or triangular.

Cushion plant – A plant found in alpine environments that grows low to the ground, with short, dense branching stems and a central taproot.

Dehisce – To split or open, discharging seeds, pollen, or other contents, as the ripe capsules or pods of some plants.

Demographics – The study of fecundity and mortality parameters that are used to predict population changes.

Dentate – With spreading, pointed teeth.

Dormancy – A period of growth inactivity in seeds, buds, bulbs, and other plant organs even when environmental conditions normally required for growth are met.

Endangered – Defined in the Endangered Species Act as a species, subspecies, or variety likely to become extinct in the foreseeable future throughout all of its range or extirpated in a significant portion of its range.

Endemic – A population or species with narrow physiological constraints or other restrictions, which limit it to a special habitat or a very restricted geographic range, or both.

Entire – Having a margin that lacks any toothing or division, as the leaves of some plants.

Erect – Upright habit of growth.

Fellfield – Alpine community characterized by rocky ground, dry soils, and cushion plants.

Fertility – Reproductive capacity of an organism.

Fitness – Success in producing viable and fertile offspring.

Fruit – The ripened, seed-containing reproductive structure of a plant.

G1 ranking – Critically imperiled globally because of extreme rarity (five or fewer occurrences or very few remaining individuals) or because of some factor making it especially vulnerable to extinction (NHP).

G2 ranking – Imperiled globally because of rarity (6 to 20 occurrences) or because of factors demonstrably making a species vulnerable to extinction (NHP).

G3 ranking – Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences) or because of other factors making it vulnerable to extinction (NHP).

G4 ranking – Apparently secure, though it may be quite rare in parts of its range, especially at the periphery (NHP).

G5 ranking – Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery (NHP).

Genotype – Genetic constitution of an organism.

Glandular – With glands.

Habitat isolation – When two or more habitats are separated (i.e., geographically) to an extent to prevent cross breeding, thereby genetically isolating two parts of a once continuous population.

Habitat fragmentation – The breakup of a continuous landscape containing large patches into smaller, usually more numerous, and less connected patches. Can result in genetic isolation.

Hybridization – The result of a cross between two interspecific taxa.

Inflorescence – The flowering part of a plant, usually referring to a cluster of flowers.

Interspecific competition – Competition for resources between individuals of different species.

Mesic – Characteristic of an environment that is neither extremely wet, nor extremely dry.

Metapopulation – Group of populations that are linked through migration of individuals.

Monocarpic – Flowering and bearing fruit only once.

Mycorrhiza – Symbiotic association between a fungus and the root of a higher plant.

Ovary – The enlarged portion of the female reproductive structure (pistil) that contains the ovules and develops into the fruit.

Ovate – Egg-shaped (two-dimensional), with the broadest end toward the base.

Ovule – Part of “female” plant reproductive system that becomes a seed after fertilization.

Panicle – Branching, indeterminate inflorescence, usually broad near base and tapering up.

Perennial – A plant that lives for 3 or more years and can grow, flower, and set seed for many years; underground parts may regrow new stems in the case of herbaceous plants.

Perfect flower – Flower with both “male” (stamens) and “female” (pistils) reproductive organs.

Perianth – Part of flower consisting of calyx and corolla, usually used when these structures are incomplete or modified.

Petiole – Leaf stalk.

Phenotype – The external visible appearance of an organism.

Phenotypic plasticity – When members of a species vary in height, leaf size or shape, flowering (or spore-producing time), or other attributes, with changes in light intensity, latitude, elevation, or other site characteristics.

Pistil – The seed-producing organ of a flower, consisting of a stigma, style, and ovary.

Pistillate flower – A flower with “female” reproductive organs (pistils) and lacking “male” reproductive organs (stamens).

Pollen – The male spores in an anther.

Polyploidy – Having more than two complete sets of chromosomes per cell.

Population Viability Analysis – An evaluation to determine the minimum number of plants needed to perpetuate a species into the future, the factors that affect that number, and current population trends for the species being evaluated.

Propagule – A reproductive body, usually produced through asexual or vegetative reproduction.

Pubescent – Bearing hairs.

Recruitment – The addition of new individuals to a population by reproduction.

Reniform – Kidney-shaped.

Rhizome – Prostrate stem growing beneath the ground surface, usually rooting at the nodes.

S1 ranking – Critically imperiled globally because of extreme rarity (five or fewer occurrences or very few remaining individuals) or because of some factor making it especially vulnerable to extinction (NHP).

S2 ranking – Imperiled globally because of rarity (6 to 20 occurrences) or because of factors demonstrably making a species vulnerable to extinction (NHP).

S3 ranking – Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences) or because of other factors making it vulnerable to extinction (NHP).

S4 ranking – Apparently secure, though it may be quite rare in parts of its range, especially at the periphery (NHP).

S5 ranking – Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery (NHP).

Scree – Accumulation of small rock debris (generally smaller than talus), often at base of cliff or steep slope.

Semelparous – Reproducing only once throughout a lifetime, usually followed by death.

Senescence – Changes that occur in an organism (or part of an organism) between maturity and death; aging.

Sensitive species – A species whose population viability is a concern due to downward trends in population numbers, density, or habitat capability, as identified by a regional forester (USFS).

Sepals – A segment of the calyx.

Sexual reproduction – Reproduction involving the union of gametes.

Stamen – The pollen-producing structures of a flower; the “male” part of a flower.

Stigma – The surface of the plant reproductive structures (pistil) on which pollen grains land.

Stipule – Basal appendage found in association with leaves of many species.

Style – Stalk-like part of the pistil that connects the ovary and stigma.

Succession – The orderly process of one plant community replacing another.

Symbiotic interaction – An intimate association between two dissimilar organisms that benefits both of them.

Sympatric – Occupying the same geographic region.

Talus – Accumulation of coarse rock debris (generally larger than scree), often at the base of cliff or steep slope.

Threatened – Defined in the Endangered Species Act as a species, subspecies, or variety in danger of becoming endangered within the foreseeable future throughout all or a significant portion of its range.

Tors – Towers of balanced rocks or boulders.

Tubercle – Small swelling or projection.

Urceolate – Urn-shaped or pitcher-shaped, contracted at or just below the mouth.

Vegetative reproduction – A form of asexual propagation whereby new individuals develop from specialized multicellular structures that often detach from the mother plant.

Viability – The capability of a species to persist over time. A viable species consists of self-sustaining and interacting populations that have sufficient abundance and diversity to persist and adapt over time.

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